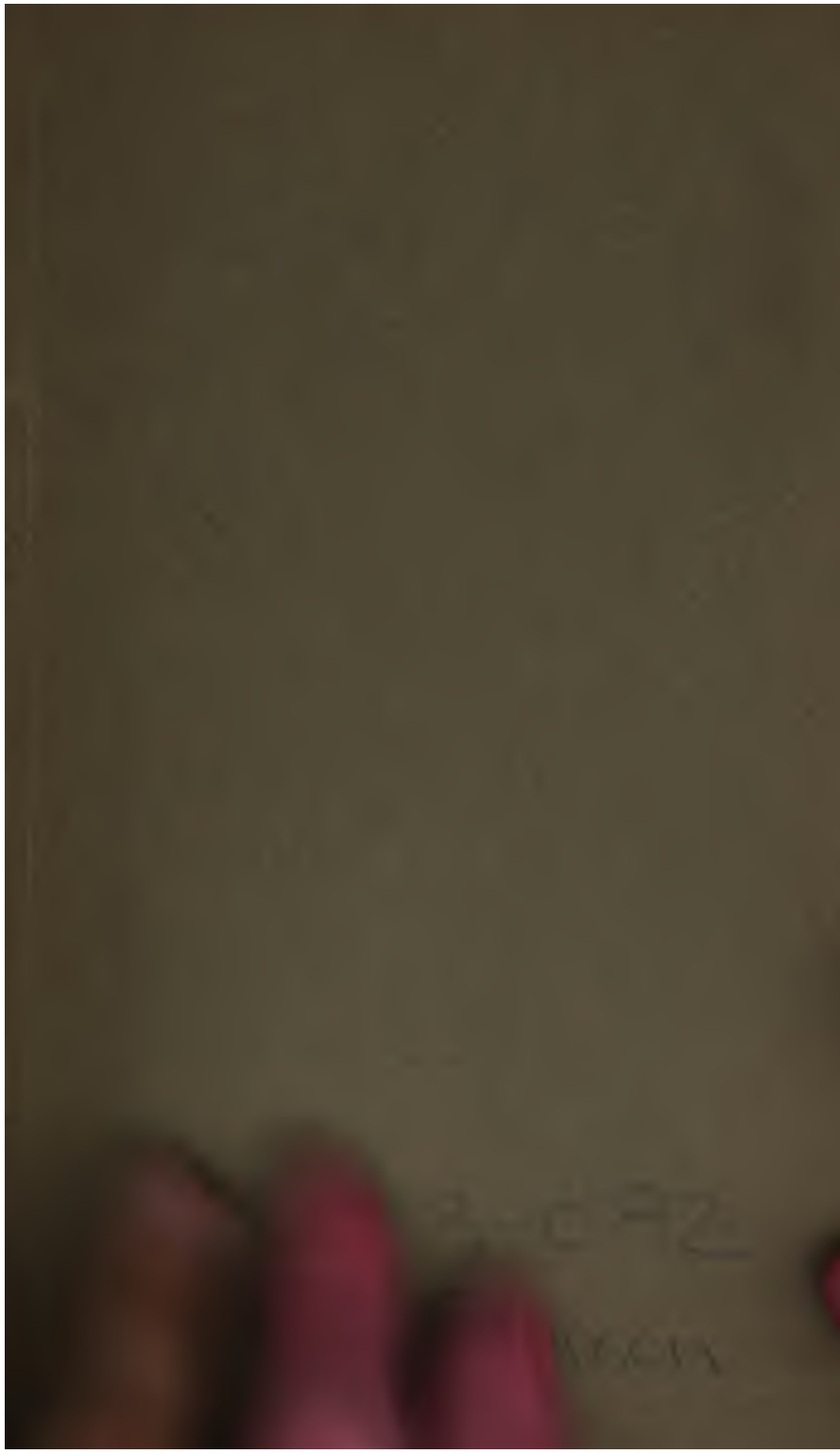

I AM TOUCHING SUBJECTS CONSECRATED BY LONG REVERENCE, THE RIPE THOUGHT AND THE EARNEST CONVICTION OF THE MOST ILLUSTRIOUS AND EXPERIENCED THINKERS KNOWN IN THE HISTORY OF MAN; BUT WITH ALL DUE RESPECT FOR THE TREASURED WISDOM OF AGES, GATHERED, CONDENSED AND UTILIZED BY GREAT PATIENCE AND INDEFATIGABLE INDUSTRY, I MUST SAY, THAT IT WILL AMOUNT TO NOUGHT, IF IT SHRINKS FROM THE WAND OF TRUTH: OR IF, FROM THIS PRETEXT OR THAT PREJUDICE, IT AVOIDS THE LIGHT OF INQUIRY.

MY VISIT TO THE SUN;

OR,

CRITICAL ESSAYS

ON

PHYSICS, METAPHYSICS, AND ETHICS.

BY LAWRENCE S. BENSON,
AUTHOR OF "BENSON'S GEOMETRY."

"Cœli enarrant Gloriam Dei."

Vol. I.—PHYSICS.

ELECTROTYPED EDITION

NEW YORK:
JAMES S. BURNTON,
149 GRAND STREET.
1874.

ADVERTISEMENT.

THIS volume is a re-print from the English edition published in London during the year 1864, and is offered to the American reader, revised and enlarged. It relates to Physics, or Natural Philosophy; but the work, when completed, will be critical reviews of Physics, Metaphysics, and Ethics; and it will contain, in the most concise manner possible, much information in Science and Art that must otherwise be sought in numerous volumes on those subjects. An able critic says, "The views of the author are presented in the form of an allegory. He conceives himself on the sun, where he surveys the universe; he pictures to himself the aspects, relations, and conditions of things totally different from what they seem on the earth; and from his exalted standpoint he criticises the *theories* of Gravitation, Central Forces, Projectiles, Hypothetical Astronomy, Atomic Chemistry, Electricity, Galvanism, and Magnetism; he advances some new notions of *matter;* he proclaims the seeming paradox that the heat we feel in the sunlight is not emitted to us from the sun; and that we never can obtain any knowledge of CAUSE. He promises, at some near future time, to dissipate the mists of Metaphysics,

and to solve some knotty questions in Ethics. The work is original in conception, comprehensive in plan, bold in character, vigorous in style, exhaustive in research, forcible in argument, poetical in diction, and erudite in treatment. It challenges the scrutiny of savans; it is readable and instructive, and will repay many perusals. We are anxious to see the continuance of it, as we regard it as a wonderful work, and we esteem it as a valuable acquisition to our stock of scientific lore."

INTRODUCTION.

THE best and most profound thinkers, from the earliest antiquity, have interested themselves with the reasons, whys and wherefores of the existence of things. They seem to have agreed upon the necessity for some origin, cause or author of things; but concerning the nature, attributes or qualities of this origin, cause or author, they have differed in their conceptions, reasonings and conclusions. Now, when men reason from different standpoints, adopt particular definitions from constitutional abilities, or argue from premises peculiarly constructed, their convictions cannot agree, however correct may be their deductions, or precise their inferences; and charity should be felt by mankind for opinions honestly entertained.

The fact that men agree to assign some origin or cause for things is significant, and it should encourage humanitarians to bear patiently with those views about which mankind honestly differ; because this fact shows that when men can look at things from the same standpoint, can adopt the same meaning for their words, and can use the same premises for their reasoning, they will necessarily agree in their conclusions; which is verified by

geometrical truths. Here all men consider geometrical properties in the abstract, apart from all real or material existence; here they adopt the same axioms and modes of demonstration, and consequently, their conclusions agree. Now, when thinkers direct their minds to things which they behold around, above and beneath them, they perceive incessant changes taking place; they see some things, as it were, bursting into existence, some things maturing their properties, qualities and conditions, and some things decaying or vanishing from existence; they will notice a mutual dependence between all things, and they will observe certain relations and connections produced, modified and affected by circumstances, by which all things have periods of commencement, maturity and decay; they will note results arising from certain circumstances, and discover that like circumstances precede like things. All these things are presented through the *media* of the senses, the same to all men; hence, in this respect, they view things from the same standpoint; therefore, from the mutual dependence, the certain relations and connections between things, all thinkers will conclude that no thing can exist independently and separately from other things; whence, by easy reflection, they will arrive at the fact that no thing is self-existing; hence, their intellect will suggest that nothing originates from itself, that all things have some origin, and that all effects have some cause. Thus far all thinkers agree, because they perceive these things through the same *media;* but in seeking the nature, attributes and qualities of this author, origin or cause, thinkers go beyond the surveil-

lance of their senses; hence, fancy and imagination govern their reflections; and as each thinker has his own peculiar fancy and imagination, the reason is apparent why thinkers differ in their speculations.

Some thinkers, seeing the mutability of things, but at the same time observing their ready adaptedness for some purpose, their order, arrangement and the identity in their effects, their happy and wise disposition, cannot conceive how the author of things can be traced among things; hence, they believe that the author of things must be unlike all things, and must have a nature, attributes and qualities superior to those of things. While other thinkers, being unable to conceive of a nature, attributes and qualities superior to, and different from those of things, and being able to perceive things in their natural orders and conditions only, believe that things exist from the *necessity* of their common and mutual relations, and they endeavor to symbolize the concurrent actions, multitudinous operations, diversified motions, and incessant changes of things, into the author or origin of things, which they call Nature. Hence, one class of thinkers, from feelings of gratitude and dependence, and with great pertinacity of deportment, will conform to systems of religion, varying with circumstances and modified by social regulations, consisting of orisons, liturgies, sacrifices, penances, expiations, rites, sacraments, praises and solemn ceremonies, and the erection of temples, edifices, tabernacles and other places of worship, for an omnipotent, omnipresent and omniscient Spirit, whom they believe to be God, who created, regu-

her one gleam of success. Her solicitors and admirers are innumerable; but, with abilities incommensurate with their zeal, they have hunted and chased her till, in their eagerness, they have grasped her shadow, and have embraced it with ardor, whilst the *divine substance* has eluded them.

LAWRENCE S. BENSON,
Author of "Benson's Geometry."

NEW YORK CITY,
February, 1874.

MY VISIT TO THE SUN.

SUFFICIENT time having elapsed, since my return from the most remarkable voyage of either ancient or modern times, for my mind to become quiet and calm, and my thoughts to arrange themselves in their proper order, I will essay to connect the various notes taken in my travels, and give, in a coherent whole, the observations and discoveries it has been my privilege to make. I know "my commentaries" will be placed by some among fictitious effusions; some will be interested from their novelties; some will be startled from the boldness of their expositions; some will be chagrined from the discoveries, which will explode their favorite theories; some will be delighted from the realization of their most dream-like speculations; some will be glad for the opportunity which has enabled me to substantiate truths which bias and prejudice and ignorance have doubted; some will be able to learn from my observations and discoveries lessons of sterling wisdom, and gather pearls, gems, and jewels of erudition; some will see the purpose and object of my voyage to place beyond cavil and dispute things which have been ruminated over by

the wise; which have interested the minds of the learned; which have been believed by the good and holy; which have inspired some of the most gifted poets; which have given enchantment to the airy-nothings and fairy visions of the dreamer; which have given food to the hungry mind of the thoughtful; which have puzzled the clearest intellects, and have made the common sense of the many superior to the genius of the few.

Had I neglected to note down each event at the time and place of occurrence, I would not now be able to give a true and faithful account, because so new, startling, and unexpected were the numerous acts of the most wonderful spectacle, never before witnessed by a terrestrial, or even lunary being, that even now "a mass of many images crowd like waves upon me," and I am compelled to resort to the pages of my journal to give the precedent of time, and the most important circumstances connected with the various incidents of my voyage to, and travels over, the sun.

The philosopher—that lover of truth and wisdom—will be so much occupied with the *result* of my expedition, that it will be of secondary importance to acquaint him of the means by which I succeeded in reaching the sun; and he will know that mechanical ingenuity is so unbounded, that what seems impossible and marvellous to some, is natural and ordinary to others. The inquisitive—that idler upon the thoroughfares of knowledge—is so insatiate in his demands for the reasons, and whys,

and wherefores, that if I should tell him by what means I was conveyed to the end of my journey, he will be anxious to know how many days it took me?—how many persons I met on the way? and a myriad of other questions, which, being answered, would thus prevent me from devoting the little time I have to my narrative; and which not being told he can turn his curiosity to account, and learn from my reticence my intention to reveal nothing more than these pages unfold.

Accustomed as I have been to see from *reflected* light only, I felt strangely when I saw everything around me shining with a light of its own, when the natural condition of things was so simple, so self-explanatory, and so clear; and used as I have been from my earliest infancy to have the strong wines of truth diluted for me, that when I stood in the naked simplicity of everything around me, I felt awed and confused, as when on earth some wonderful phenomena have raised emotions of grandeur and sublimity. As our intensest feelings are not of long duration, so I became gradually conscious of the change I had undergone in passing from the sphere which receives its light by reflection to the origin and source of light. My faculties, which seem before only adapted to an earthly state, became, as it were, newly developed, and suitable for that essentially luminous region, and I discovered that what seemed to me to be newly-created powers, were only dormant and unexercised before; and I felt like a new being in the full

display and rational exercise of the faculties of my mind, of my corporeal senses, and of the powers of my body. From the pages of my journal I can give the various incidents of my travels: the composition, character, and quality of the soil of the sun; describe the most paradisiacal scenery, which no terrestrial being has ever beheld; depict the character, condition and pursuits of the people I met; relate my conversations with them, suggestive of many improvements to my earthly fellow-beings; showing the high state of knowledge among the inhabitants of the sun, in contrast with the process of education resorted to by my earthly fellow-beings in training their minds, which, after what I have seen, is nothing more than *straining the reason to adapt itself to an artificial condition necessitated by reflected light;* indeed so marvellous and wonderful were what I saw and heard, that I can fill volumes with the grandest conceptions of truths, the most ingenious mechanical contrivances, and the most exceedingly interesting manipulations, but ordinary and commonplace only to the people of the sun. I have no doubt my readers will be better pleased with extracts from my journal than my comments, as the extracts will enable them to form their own opinions, which are more pleasing and satisfactory to oneself than the comments of another. I will therefore give the extracts, using the same arrangement as there is in my journal, because the notes were taken at the time the events they relate of were transpiring, and

are evidently more faithful, however less improved, than posterior reflections can make them. My first note was written after I had become conscious of the new development of my mental faculties and physical powers before referred to, and reconciled to the changed condition of my situation, and when I had concluded to describe my sensations and the general aspects of things for future reference. Here is my first note:—

How differently the firmament appears from the surface of the sun than from the earth! From the latter, our vision is bounded by a hemispherical dome, which seems to rest upon the extended surface of the earth; but from here, I can see no such dome, and vision extends to an unfathomable distance. I see bodies moving to and fro, but they are not studded so thickly like they appear from the earth, but their distances from each other are great and uniform; there is a regularity in their movements which I could not think possible when I looked at them from the earth. It is daytime, and still I see the bodies. I cannot call them orbs, or even stars, for they are dark, not bright as when I saw them from the earth; and I see innumerable comets, I suppose they are, because they move more quickly than other bodies, although they have no streaks of light or tails behind them. Some are going and others are coming; some, away in the distance, are ascending, and others are descending. How numerous they are! How grand the survey of the universe from the sun! How insig-

nificant the view of the skies from the earth! On every side of me my vision is unbounded, and the whole universe is animated. What on earth is called animal life seems possessed by the whole universe. List! I hear the buzzing like a bee-hive; is it possible that the movements of the bodies produce this peculiar sound? And in my first astonishment—the enchantment of my eyes—I did not notice the harmony of their movements. How much we are deprived of on the earth! How little we comprehend of the magnificence and immensity of the universe! Strange. I do not see the azure which envelopes the heavens when looked at from the earth. But there is a *clearness* around me, which extends indefinitely whichever side I look; and this is the reason why my vision is so unbounded. There is a softness and brightness of light here which is so different from the glaring and dazzling light which is seen on the earth. Here the light emanates from you, penetrating the most opaque substances, and reaches to an unlimited distance, and light is the essence of everything, and embodies the universe, dispossessing distance of its obscurity and depriving matter of its opacity. While on the earth, darkness is in you; the light is reflected to you: darkness is the inherent property of all things; light is extraneous; there is a continual struggle between darkness and light; darkness being native to the earth, and light foreign: the former obtains the mastery, and envelopes everything with its unsightly man-

tle. Oh, how delightful to view nature in her simplicity, her purity, and her clearness! The soul, which is clogged on the earth, is here free, untrammelled, and unrestrained. It partakes of the essence of light, and is imbued with the simplicity, purity, and clearness of nature. It becomes a part of the Great Intellect and Creative Genius of the universe.

The surface of the sun is even—not rugged, like the surface of the earth; but there is no monotony in this evenness of surface; it has a charm, a beauty, which the most undulating landscape on the earth cannot convey, owing, no doubt, to the fact that darkness being the inherent property of all things on the earth—a diversity, a contrast, an intermingling of light with shade, become necessary to give beauty to the scenery on the earth; while on the sun light is supreme. A diversity, a contrast, an intermingling of light with shade, will mar the prospect, and destroy the beauty imparted from the excellence of light.

How smooth, transparent, and placid the waters; not a ripple seems to disturb their rest; there is a sublimity and grandeur in this quietness far surpassing the emotions of awe and fear arising from the most violent agitation and tempest-tossed waves of the ocean on the earth. Here vision annihilates distance, and what on earth is deemed unfathomable, boundless, and infinite, fails here to reach the boundaries, or even the outskirts of sight: infinitude on earth is finitude here. Although

no wind interrupts the calmness and tranquillity which imbue everything around me, there is a delicious freshness, invigorating from its very repose. My senses are acutely affected by an intensely ethereal and invisible power, far surpassing in delicacy the finest vibrations of the nicest-strung Æolian harp—there is a rapture, a transport in my feelings. The air around me is filled with fragrance of the most delightsome sweetness, which impregnates everything, and thus perfume of the most grateful odor becomes prolific and ubiquitous.

The ground is covered with an herbage of the most velvety softness and of the purest whiteness, which, from the highly-developed state of my ocular organs, and my mind being so richly imbued with simplicity, clearness, and purity, and the irresistibility of all things to light, this whiteness is appreciated, attractive, and charming. While on the earth, owing to reflected light, and the consequent cloudiness of the sight, and the imperfectly-developed faculties of the mind, tints of most uncelestial descriptions, and colors of the most earthy, material, and grossly natures, are necessary to appease the fancy, and gratify the ill-developed and perverted susceptibilities of the soul.

The soil is of the same nature with everything else around me—of the utmost whiteness and purity, resembling diamond dust, but more clear than the most pellucid crystals found on the earth.

The body of the sun is transparent, and I can discover nothing showing it is not elementary; the

same evenness, clearness, and purity I see on the surface extend through the inmost depths and extremities of the mass, and the light which is innate, is mellow, soft, and bland, so unlike the light on the earth; everything about me partakes of the nature of the sun, and light is the only element discoverable, which is impossible to be otherwise, since so permeating is its essence and so irresistible to its influence is the nature of everything here, that light is constitutionally the only ingredient possible. I walk, still so effortless, that I seem borne rather than moving by my own volition. If I was possessed of my earthly faculties and powers only, I would be unsteady, giddy, and fearful, but owing to their better development, I walk firmly, my mind is clear, and I feel no dread. I will go and speak with that person I see coming towards me. Ah! he notices me. I wonder if he knows that I am a stranger here, just from the earth? He salutes me—

"Good day, sir."

I will go nearer to him, and converse with him.

"I am amazed, sir, at the grandeur, sublimity, and the wonderful movements of the universe. I am enchanted with the melody and concord in the bodies which are so busy and animated around me. I am struck with the illimitable extent of the sight, and at the clearness of vision. I am delighted with the brightness of the light, with the beauty and purity of everything around me, and I think, sir, how ineffably happy must be your lot to

dwell amidst scenes so inspiring of all that is noble and grand; and so conducive to the perfection of all that is good, all that is pure, and all that is true."

The Man of the Sun replied—

"I rejoice to meet you; what you have so graphically and so truthfully described, I do not wonder fill you with amazement and delight, and startle you because they are new and unexpected to you."

To which I replied—

"I am considerably interested to know why on earth my sensation of light is associated with heat, and here I am upon the sphere which is supposed to be the concentration of heat, and I experience no discomfort, and I am not even conscious of the existence of heat. This is to me more startling and new than anything I have yet seen, felt, or heard."

The Man of the Sun answered—

"All your knowledge you base on the testimony of your senses, therefore you cannot have any knowledge unless derived through them; and thus your sensibilities being the medium through which you obtain your knowledge—your intellects become controlled by them, and the faculties of your mind adapt themselves to the condition of your knowledge, to your habits, and the circumstances by which you are surrounded."

I here interrupted the Man of the Sun thus—

"Your words are enigmatical to me. I grant you that on the earth we are governed by the testimony of the senses, and for that very reason we

are assured that whatever knowledge we have—that is, conclusions derivable from, and referrible to, such testimony—is unimpeachable, reasonable, and evidently true."

To which the Man of the Sun responded immediately—

"By your own words I will show you where you err. You said, a little while ago, that nothing is more startling to you than that where your sensations associated heat with light, you experience no discomfort; and are not even conscious of the existence of heat, although you are now on the sphere which you supposed the concentration of light and heat. And again you said, that your knowledge derivable from, and referrible to the testimony of your senses, is unimpeachable, reasonable, and evidently true. Do you doubt your consciousness? No! Well, you are conscious now of no heat, still your knowledge on the earth which you have just commended so highly, as unimpeachable, reasonable, and evidently true, informed you that heat here, on the sun, is in its most concentrated form. Now, are you willing to place your speculations about the sun, originating on the earth, against your consciousness of the actual condition of the sun, experienced on the sun?"

I replied—"It is true, that when I regard the testimony of my senses as the medium of knowledge, I should not doubt any evidence they give. And it seems very inexplicable to me, how light and heat so intimately connected on the earth, that

here, where I find light so abundant, and penetrating the inmost recesses of everything, and when my senses are so acutely and finely developed, I should fail to discover the faintest existence of heat; but in its stead, I am sensible of a peculiarly refreshing and cooling essence, which is here the accompaniment of light, and is as much influenced by light as on earth I have found heat."

The Man of the Sun answered—

"That very abundance of light, and the reason of the irresistibility of all things here to light, account for the absence of all heat. One thing you have not heeded, which your senses would inform you, is this, namely: when you seek information be satisfied to be informed. You go to your senses for your knowledge, be governed by what they teach you; but do not, having learned from them some things, essay to teach yourself other things and attribute your own errors to the testimony of your senses. And learn this, what they plainly teach you, but you heed it not, that your senses are limited in their powers, and they teach only what come in their sphere; and that moment you go beyond their limits you are trespassing upon domains over which they have no jurisdiction, and from which they would withhold you, and you have no right to charge them for what they are not accountable nor responsible."

To this I replied—"Admitting that I am satisfied with what my senses inform me, then I am to believe that on the earth only heat is developed

by the action of light; but that on the sun a contrary and opposite essence proceeds from light."

The Man of the Sun responded—

"You have expressed the actual condition of what your sense of touch informs you; thus far you are right, and now you should be cautious that you do not overstep your limits. Now, with this information what do you judge?"

I answered—"Experiencing as I do a new state of being, with faculties and powers more keenly developed, with a change of circumstances, and with a different order and nature of things than what I have known on the earth, I am too much amazed, astonished, and startled to form any judgment whatever; and I must take counsel, lest I be led beyond the jurisdiction of my senses, into that region where uncertainty usurps the sceptre of reason, and my unassisted and unguided mind becomes the prey to every faction of ideas and every ism of beliefs, and be tossed about upon the sea of fanaticism, rudderless, compassless, and pilotless."

The Man of the Sun responded—

"Prudent words and wise conclusion. You have lately observed the consciousness of *physical* light without heat, which you have never supposed possible when on the earth; and I am glad to see that your new state of being, with faculties and powers more keenly developed, with a change of circumstances and a different order and nature of things, you are becoming conscious of *mental* light without heat, which you have never supposed possible when

on the earth. And when you have profited by that new state of being, cultivated your new faculties and powers, interpreted the new circumstances which surround you, and have been instructed by the new order and nature of things, you will also become conscious of *moral* light without heat, which you have never supposed possible when on the earth."

I replied—"You are again enigmatical. I can understand now from my consciousness the possibility of physical light without heat; but in what way can you explain to me the nature of mental heat or even moral heat? I can understand mental light and moral light—which I suppose you use figuratively for truth and right. And as physical darkness is contrasted with physical light, I can understand that physical heat is evolved under certain circumstances; but in what manner is inexplicable by my means of knowledge. Mental darkness I contrast with mental light, or error with truth; and moral darkness I contrast with moral light, or wrong with right; but how mental heat can be evolved by mental light, or in what nature it can be said to exist—and the same of moral heat—I am at a loss to conceive; and also, how our mental faculties or moral instincts can be made acquainted with heat, which should make me cautious, as you have just counselled me. I should be governed by what my senses teach; otherwise, my knowledge will become fancy, and my reason will become imagination."

The Man of the Sun responded—

"You forget where you are, and where you are from. Have you not learnt from your sense of touch that light can be without heat? and have you not on that knowledge, but lately, made a resolve to be cautious in your judgment, else ideas deprive you of your conviction, and beliefs hold in captivity your reason? Then remember your resolve—Can you define heat?"

I answered—"No; but I can tell you what I know of it from its effects."

The Man of the Sun replied—

"You cannot, else you would know what are mental and moral heat. You know none of its effects, otherwise you would not have been startled to find no heat on the sun. You have said that you are in a new state of being, that your faculties and powers are more keenly developed, that you are amidst a change of circumstances, and that you are with a different order and nature of things. I am not surprised at you saying what you have. Look around, above, and beneath you—distance is annihilated—your vision is unlimited—on the earth illimitability is an idea, here it is a fact. List, you hear the music of the universe; on the earth this harmony was only dreamed,—here it is realized. On the earth, your movements were attended with labor, toil, and pain; here, you move without an effort, you are invigorated and refreshed as you proceed. On the earth, you are subject to agony, disease and decay; here, your nerves are attuned,

and played upon by the spirit of music, and touched by the essence of song and euphony. On the earth, error, doubt, wrong, darkness haunt you continually; here, all nature is purified, light everything impregnates and everywhere penetrates, and truth in its clearness, simplicity, and genuineness, instructs and animates. The things you see here have been always, but they are new to you; hence, startling and strange to what you hitherto believed. When I ask you to define heat, you are ready to tell me what you know of it by its effects, in the face of your ignorance that physical light could exist without heat, and with no conceptions of mental nor moral heat. Do you think, then, that what you could tell me would in any way be satisfactory or convincing to me? And is not your idea of heat erroneous, and arising from a misunderstanding of its nature and properties?"

I immediately rejoined—"I do not dispute your knowledge of the grandeur and beauty of the universe, of the piercing, impregnating and ubiquitous properties of light, of the finely wrought susceptibilities of your nature, of many things with which you are familiar, dwelling as you do where there is such a clearness, perspicuity, and simplicity of everything around you; but I think fairly and reasonably, that what can be explained, proved, and known on the earth by the senses—without which testimony you cannot examine, prove, or know anything on the sun—is unimpeachable even here on the sun, from the fact, which you will admit

yourself, that heat, of which you have no evidence, here, can be better explained and understood on the earth, where its effects can be seen, felt, and examined."

The Man of the Sun replied—

"I understand you: you think, because you have felt, seen, and examined on the earth what you call the effects of heat, and nowhere you have been able to discover the existence of heat on the sun, that you, coming from the earth, ought fairly and reasonably to be allowed to have your exposition of heat unimpeached, and for that reason, you are better able than I am, living on the sun, to judge correctly of its effects, and to speak understandingly of its nature. You shall not have cause to deem me unfair and unreasonable; and I will listen patiently, and I hope edifyingly, to all you have to say."

I responded—"On the earth heat is perceived by the sense of touch, and it occasions much unpleasantness and discomfort when raised to a high degree. Light has never been known without heat, although heat is not discovered to be always accompanied by light. Heat is evolved by combustion, friction, fermentation, chemical action, electricity, magnetism; we have latent heat, and specific heat; heat can be conducted, radiated, reflected, refracted and undulated; experiments are being made to discover its nature and properties, which promise to place heat in importance in the economy of nature coeval with the other forms of force, such as light, electricity, magnetism,

motion, gravitation, and chemical affinity; heat nourishes animal and vegetable life, and in inorganic nature its effects are great; through the agency of heat water changes its nature, and is transformed into vapor, which, being lighter than air, ascends until it meets a current of air of a colder temperature than itself, and it becomes condensed into cloud, and, finally, precipitated in the form of rain; this rain falling upon the surface of the earth refreshes the grass, herbs, plants, and trees, and permeating the soil, it dissolves their mineral food, and dilutes the acids, and conveys ammonia and other nourishments, to their roots, adding to their growth, increasing their strength, and imparting to them vigor and energy; this rain forms springs, from which run rivulets, brooks, creeks, rivers, ponds, lakes and seas. In this way the water which was first transformed into vapor by heat, returns again to the ocean; thus, through the instrumentality of heat acting on water, the surface of the earth is irrigated, alluvial sediments are deposited. The soil is continually changing its character—hills and mountains washed down, valleys filled up, the land protrudes into the seas and oceans, and the waters overflow the land; and thus, silently, steadily, vigorously and actively, we have revolutions and counter-revolutions transpiring around, beneath and above us, changing unceasingly the nature, character, and aspects of the surface of the earth.

"By the action of heat upon the land its temper-

ature is increased, and by the process of conduction the heat is conveyed from the immediate surface to the adjoining particles, this action of the heat being continual and unceasing, and the process of conduction never varying: we have thus an accumulation of heat towards the centre of the earth. This heat, which is conducted towards the centre, having no escape and ever accumulating, becomes condensed and concentrated. Heat in its concentrated form produces combustion, this combustion is stimulated by matter. Matter being abundant, and heat constantly concentrated, this combustion steadily increases, and we have internal fires and volcanic commotion. Owing to the ceaseless energy and eternal activity of heat, we have an infernal animation in the bowels of the earth, consuming every substance, and threatening destruction to every form of matter. This internal commotion being ever stimulated, nourished, and urged on, becomes too great for the interior of the earth; it breaks out on the surface; land is elevated and depressed; earthquakes engulf miles of surface; volcanoes burn, bury, and destroy districts and every vestige of organic life; islands and continents are upheaved in the ocean, and in turn sunk beneath its waves. That heat which cannot find vent to the surface of the earth on account of the obstructions of the waters, forces itself in them, thus creating endless and impetuous convulsions in the abyss of the deep, giving cause to continual flow and re-flow of currents beneath the surface of the

waters, by which means substances which cannot be affected by the action of heat upon the water and land at the surface, are conveyed from one place to another; the saline properties of matter dissolved and disseminated throughout the entire mass of water, and thus preventing the effluvia of corruption and mortification from endangering the lives of animals subject to that element. This energetic boiling and turmoil in the economy of nature, keeping the water in this unceasing agitation, where the action of heat on the surface cannot reach, tend to purify the entire mass and prevent stagnation.

"Again: the air which surrounds the earth is heated by contact with the surface, owing to a wise provision of nature; because, if the air could be heated from above, we would be subject to two deplorable alternatives—granting that we were on the earth—which are, that of being frozen or consumed; because—owing to the property of heat to be conducted—heat, in the event of air being affected by its passage through it, would be either dissipated and reduced by the immensity of the universe, or accumulated and concentrated by the perpetual, inexhaustible, and everlasting state of its nature.

"In either case, everything on the surface of the earth would be destroyed; which was not destined to be, therefore air was wisely and mercifully ordered to be heated by contact with the earth. The air being thus heated, is deprived of its gravity and ascends; the cold air which is above being

heavier, descends to restore the equilibrium; and in this way we have a continual commotion also in the air, which tends to carry off a portion of the heat which is not conducted towards the centre of the earth. In addition to heat being capable of conduction, it can be radiated, reflected, refracted, and undulated—which, owing to the intermixture of land and water, and to the unevenness of the surface of the earth, occasioned by the action of heat upon the water and land—the action of heat upon the air becomes, as it were, spasmodic and irregular, and we have winds, gales, hurricanes, tempests, storms, and tornadoes, which like the effects of heat on water and land, the effects of heat on air are auxiliary in the eternal formation and re-formation of the surface of the earth, distributing the clouds around the earth, penetrating every cavity and recess in the surface, and in this way assists combustion—driving the waves of the ocean against rocks and the shore, which wash away some portions, drift other portions, and finally deposit them in the abyss of the deep. And thus we have also a perpetual change operating on the surface of the earth by the instrumentality of the heat acting upon the air. Although so violent, great, and irresistible the action of heat on the earth, still, by the dispensation of Omnipotence, Omnipresence and Omniscience, we have convulsions checked, annihilation neutralized, and disorder regulated. Although the action of heat is great on water, it is, however, counterpoised by the action

of heat on land and air, and each in turn restrained by the others, and thus by an equilibrium of forces, whatever is impaired by the one is restored by the other and is, in the course of time, replaced by itself. And thus, by the apparent indestructibility of matter, these operations seem likely to continue for ever. At the same time, these operations are so grand and so widespread, their immediate effects and action are scarcely perceptible; but so silently they are going on around, beneath, and above us, that we are not conscious of them until after an elapse of time and the accumulation of their effects. And thus by Beneficence the earth is capable of sustaining animal and vegetable life, and the surface of the earth is perpetually regenerated and renovated.

"Though heat is consuming, destructive and annihilating in its essence, still from this very essence is everything restored, repaired and preserved. Heat transforms water into vapor, which rises and becomes condensed into clouds, and is precipitated in rain, which, being colder in temperature than the particles of matter on the land, tends to moderate the temperature of the earth which had been heated; and in the same manner the heated air acts, carrying off a portion of the heat of the earth, whose place is supplied by cold air from above, which in turn becomes heated, ascends and gives place to colder air from above, and so on; and while the action of heat on the water and air tends to carry off the heat of the earth, the

particles of matter conduct a portion of heat from the surface to the centre of the earth; the heat having no escape from the centre accumulates and becomes concentrated and the centre acts as a reservoir for heat, to restore the equilibrium of heat disturbed by the action of heat upon the water and air. And in this way, in the economy of nature, heat is at once the consumer and repairer, the destroyer and restorer, and the annihilator and preserver. A mean temperature being in this manner maintained on the surface of the earth, it becomes fit for the abode of animals and the sustenance of vegetables. These animals and vegetables are nourished, flourish, and are matured by the operations of heat. The germ, warmed by the grateful temperature of the earth, expands; from the moistening power of the refreshing rain, bursts its shell, takes root, and grows, from the united action and beneficial effects of heat upon the land, water, and air; the grass, herb, plant, and tree flourish, thrive, and mature, and, as unceasing as the activity of heat is, vegetation endures. In like manner, by a beneficent concatenation of circumstances, animals exist, thrive, and mature. The habits of vegetables are simple, their wants are few, and their conditions are plain, and the ordinary operations of heat satisfy them; but with animals it is different; their habits are so complicated, and, in many cases, so artificial—their wants are so numerous and so compounded, and their conditions so varying and so uncertain—that the ordinary opera-

tions of heat are insufficient. A vegetable will germinate, grow, flourish, mature, and decay upon the same spot; an animal is possessed of locomotion. Since food and nourishment are the sustenance of life, vegetables receive them by the ordinary operations of heat, and animals seek them, and consequently the operations of heat must be diversified. Heat being conducted by the particles of matter to the germ, is by it absorbed, and continually accumulates as the germ expands, takes root, and grows; and in this way heat, besides bringing food and nourishment to the vegetable, enters the vitals of the vegetable, and by its unceasing energy and eternal activity, stimulates the growth and developes the structure of the vegetable. During the incipient state of the animal, heat is conducted to it similarly as to the germ of the vegetable, and in the same manner enters its vitals, stimulating its growth, and developing its structure; but in the facility of food and nourishment, the operations of heat become diversified—suitable to the habits, wants, and condition of the animal—and as these habits, wants, and condition are simple or complex, few or many, constant or varying—in the same way are the operations of heat. Upon the structure of the animal will depend its habits, wants, and condition, and consequently its facility of food and nourishment. And as heat developes its structure, so will its habits be formed, its wants become known, and its condition suited. From the lowest order of animals to the highest, we are

struck with a regularity of difference and a diversity of sameness, which show the adaptation of universal principles and the application of order, arrangement, and agreement. Brutes and all animals below man have simpler habits, fewer wants, and plainer conditions—hence instinct, varying with their structures, satisfies them; but man, whose habits are more complicated and artificial, whose wants are more numerous, and whose condition is more varying and uncertain, requires the aid and guide of reason; and as the condition of man varies, his wants increase and his habits are more complicated and artificial. Animals possessing locomotion, and their structures being developed by heat, their faculties and powers are stimulated, accelerated, and matured by the operations of heat, and their food and nourishment supplied by their exertions; hence, accordingly as their habits are simple, complicated, or artificial, their wants are few or numerous, and their condition plain or varying, so will the facility or difficulty of food and nourishment be regulated; and where instinct fails, reason begins; and thus animals, like vegetables, are constantly fed and nourished by the operations of heat. The lower order of animals being governed by instinct, their exertions are natural and determinate; but man being governed by reason, his exertions are ingenious and inventive. And according to his conditions, wants, and habits, will his exertions be beneficial and useful, and when the ordinary operations of heat fail

him, his restless nature so greatly imbued with the essence of heat avails him of the advantages and adaptation of heat in the forms of combustion, friction, fermentation, chemical affinity, electricity, and magnetism. And by the power of his reason, the ingenuity and invention of his exertions, he combines, modifies, and adapts the various forms of heat suitable to his condition, wants, and habits.

"How land, water, and air originated, I am unable to say, because man was formed after they were created, and it is with their present condition only that man is acquainted, and of their immediate circumstances only that man can judge, and of their existing order only man can know. In a secondary condition we have solids, fluids, and gases; they are distributed promiscuously over the earth, and they are in unity with the purpose of nature. By the ingenuity, industry, and untiring energy of man, marvellous secrets of nature have been unfolded, wonderful and beneficial designs have been interpreted, and necessary and inevitable laws discovered. Then I, coming from the earth, where the presence of heat is so manifest; where the earth is enlivened by its untiring activity, its exhaustless energy, and its eternal vitality; where the earth is constantly rejuvenated by its effects; and where light, of which the sun is the origin and source, has never been discovered without heat, need well be startled, amazed, and confounded, to find nowhere on the sun the slightest indication or the faintest existence of heat. And tell me not that I know

nothing of the effects, nature, or properties of heat, when I am fully able to inform you, living on the sun, of things which you have never seen, felt, nor dreamed. I have done."

The Man of the Sun replied—"Benighted man! do you weigh the driblets of earthly knowledge, weakened by ignorance, contorted by prejudices, and obscured by darkness, with the knowledge of one who can scan the universe? Look wherever you will, the universe is spread before you. Have you, in all your earthly conceptions, imagined so much immensity, grandeur, harmony, beauty, order, and clearness, as you now realize? Then tell me not that you can tell me of things which I have never seen, felt, nor dreamed. But if you will accord me the same patience which I gave to you, I will tell you of things which you have never seen, felt, nor dreamed. The subject of your discourse was heat; by it you made an earth. The subject of my discourse will be light; by it I will make a universe. You are no doubt struck with the absolute supremacy of light—around, above, beneath, and everywhere here—and you have no doubt marvelled that things, to all appearance material, should be so pervious to light; and you have, no doubt, wondered how things here should be so changed in their properties, natures and attributes, to what you have known them on the earth; and you will admit that when there is so much clearness, simplicity, and purity here—truth is better known, sooner seen, and more readily felt here

than on the earth. In your discourse of heat, you made use of four things, namely, heat, land, water, and air; from the action of the first upon the others, and the continual action and reaction of the effects, you have drawn a graphic, animated and interesting picture of the actual condition of the earth; but in the interpretation of the cause, or the enlivening spirit which gives animation to the phenomena, or vitality to the forces, you are sadly, deplorably, and inexcusably in the wrong. Do you refer me to your sense of touch as your testimony? I will use that testimony, and refute you by your evidence. You say you feel heat by the sense of touch. I grant it. You say that when heat acts on water, it is turned to vapor. What is heat? How do you know it acts on water? How do you know it acts at all? Can your sense of touch answer these questions? Why say you, then, you derive your knowledge of heat from the sense of touch? You know the presence of heat by the sense of touch, but nothing more. The presence of heat produces a sensation distinguishable by the touch only. You cannot know the presence of heat if you are deprived of your sense of touch, therefore all your knowledge of heat is based on your sense of touch; for, by that very reason, you, not long ago, taunted me with an ignorance of heat, because I did not feel it on the sun, and thought yourself fully entitled, fairly and reasonably to explain and describe its effects, because you claim to have seen, felt, and examined the effects of heat

on the earth. I promised you a patient hearing, and hoped to be edified; you made your argument without any interruption from me, and closed your speech with an ill-disguised self-congratulation of 'well done.' Your argument passes on the earth as the truth. If any one doubts the action of heat on land, water, or air, you will say—Feel the water, air, and land, they are warm; and when they become hot, a change is made, water turns to vapor, air rises, and substances burn; all these results you attribute to heat, because your touch informs you of an uncomfortable sensation, owing to what you call the presence of heat, and only because of your vicinity to the change which is going on, you feel heat, and without any knowledge of what this heat is, you say things are consumed by heat, water is evaporated by heat, and air is raised by heat; if I ask you why you say so, you reply, because your sense of touch informs you of the presence of heat, and you see a change going on which you attribute to the action of heat. Do you not see upon what a slim foundation your knowledge of heat is based? Is it surprising you cannot define its nature? And not knowing its nature, how can you tell its effects? Because, unless you know the nature of a thing, you cannot tell how it affects other things, or how other things affect it."

I here interrupted the Man of the Sun:

"If heat is thus devoid of action, as you seem inclined to make it, how is it then constantly present in every change attributed to the agency of heat?

In combustion, fermentation, friction, electricity, magnetism, and chemical affinity? All of these work important changes in the economy of nature, and heat is constantly present, and the effects produced are in every case the same, which are consumption, destruction, and annihilation. And when the presence of heat is constant, and the effects produced are invariable and always the same, what other conclusion can we derive, but that heat is the power which acts?"

The Man of the Sun replied—

"When you know what heat is, you will not be surprised to find whenever its presence is discovered, the identical effects are produced. You say, heat consumes substances, because, in every combustion heat is known to be present by the sense of touch. Are not smoke and ashes present also in combustion? Then, why not say that smoke and ashes consume substances, because in combustion smoke and ashes are known to be present by the sense of sight?

"You discover heat by your sense of touch, and from your argument, I learn that you consider heat as issuing from the sun. If heat issued from the sun, would it not conflict with your argument to prove the effects of heat on the earth? You have said that heat acts on air, and that heat can be conducted, radiated, reflected, refracted, and undulated. If all these be so, where do you get the cold air on the earth from, to supply the place of the heated air resting immediately on the sur-

face of the earth? Heat going from the sun, and being possessed of all the properties you say it is, in order to produce the effects you assert it does, the universe would become inflamed, else your sense of touch would have to be taken from you and everything be made *fire-proof*.

"Again: heat going from the sun, in order to warm the air resting immediately on the surface of the earth, and not the air above the earth—to suit the convenience of the people on the earth—to prevent them from being consumed or frozen, would have to be neutralized in its properties in passing to the earth, which would again conflict with your argument, for it was on account of heat being *untiringly active*, *exhaustlessly energetic*, and *eternally vital*, that it has been able to do all you claim it has done and still is doing.

"Again: heat, as you say, going from the sun, and being necessary for your argument, to be capable of conduction, reflection, refraction, undulation, and radiation, would be very much reduced after fulfilling all these offices, yet in spite of this reduction, you make heat, unlike everything else in the universe, act with more force and energy at the greatest distance, where it should be weakest, and incapable of action where it should be stronger.

"Again: heat on the earth is known to be possessed of the property of becoming more uncomfortable the nearer you approach it. Yet, heat going from the sun, which you consider the source

"I am not meagre in the admission of knowledge to the people of the earth, for the proof of which I will give you a synopsis of my observations of their industry and zeal in the acquisition of knowledge, showing you to what extent they have succeeded, wherein they have failed, and to what limits their knowledge can go. It is unnecessary to detail the successive stages in the progress of their knowledge from remote ages to the present time. Before you leave the sun, I will introduce you to antiquarians who can tell you of things which will make the revelations of antiquarians on the earth appear very modern. Until then, it will answer my purpose to treat of the present condition of the knowledge possessed by the most enlightened and civilized people of the earth. For the illustration of my object, I will suppose a man, with powers and faculties capable of obtaining the *acme* of earthly knowledge; and using it to best advantage. His five senses will be the media for obtaining the physical knowledge possessed by the people of the earth; his intellect will acquaint him with all their mental knowledge; and his reason and instinct will gain him all their moral knowledge. Since his senses will be first exercised, I will suppose him devoting all his faculties and powers in attaining their physical knowledge. Let him give all his attention in gaining all the knowledge man possesses by the sense of smell. By his olfactory organ, he will learn that bodies possess odor, he will be sensible of sweet, fetid, sour, and aromatic

acts—making the air on the surface of the earth rise, and *cold air from above descend to take the place of the warm air on the surface of the earth;* now, if the heat passed from the sun to the earth, and is possessed of all the properties you attribute to it, how could there be the *cold air above?* Hence, you have not explained how rain falls upon the earth, how the wind blows about the earth, nor how the many phenomena take place which you witnessed when you were on the earth. Think for one moment what would involve the issuing of heat from the sun. The sun would have to be not only an intensely *hot* body, but it would have to be a continually *burning* body, in order to transmit the heat the incalculable distances where the effects are produced which you attribute to the action of heat. You were not able to perceive any diminution in the light of the sun, it is still as bright as in ages long since passed away, and you have no reason to dispute why it will not continue to be the same in ages yet to come. Hence, you perceive that in order for the sun to transmit heat to the great distance the rays of light extend, and to do so from ages in the past to ages in the future, with the same *undiminished* effects, there must necessarily be an *inexhaustible* fund of fuel on the sun; in which case, you necessarily require the sun to be of *unlimited* dimensions, but your earthly philosophers have given *limited* dimensions to the sun. Or, you must give to the sun properties unmistakably an-

tagonistic to your conceptions of things—that is, the sun must be self-existing or self-supporting. For, whether you make the heat issuing from the sun the manifestation of chemical, electrical, or caloric action, you must either make the sun inexhaustible in itself or with self-sustaining properties. The former is in direct conflict with the views of the philosophers of the earth, and the latter is contrary to the conclusions of human reason. So that regarding the sun as transmitting heat you are brought in juxtaposition to two horns of a dilemma. Hence, your argument, which is the same argument used by the philosophers of the earth, unwittingly refutes itself.

"You think that heat is from the sun, because when you stand in the presence of the sun, your sense of touch informs you of the presence of heat, by the burning sensation produced; and that when you are sheltered from the rays of the sun, by some object impervious to the rays of the sun, you have no longer this burning sensation; hence you conclude that heat is from the sun, in the face of your ignorance of the nature of heat, or what heat is: all you know is, that under certain conditions you *feel* heat, but whence it comes or whither it goes, you are totally ignorant. And what makes your ignorance so deplorable, you have, without a knowledge of the nature of heat, given laws for its action, amenable to your convenience; given properties for it, continually conflicting in their attributes; and given effects for it, palpably antago-

nistic. You say heat consumes. What? Not land, water, or air. By the particles of the land, it is conducted away, according to your argument; then, in this case, there is no consumption—water is not consumed, but it is turned to vapor, by your argument, and is, after a while, restored to its original state. There is no consumption here. Heated air, by your argument, only recedes from its presence—there is no consumption here. During combustion there is no consumption, because when you accumulate the particles which have been separated by combustion, they will weigh the same as when in their united state; nowhere do you find consumption—changes are wrought, but there is no evidence to prove that heat has made them; all you know is, that heat is present when the changes are being effected, but how heat acts or what heat does, you have no evidence to show, even with the testimony of your sense of touch.

"Therefore, then, when you refer me to your sense of touch as the testimony of your knowledge of heat, your sense of touch is silent. And have you aught to say to vindicate your knowledge or defend your argument? Because, before I explain to you what heat is, and give you its cause, and tell you of things you have never dreamed, I want your mind free from every reason you cannot sustain, and from every idea you cannot define. Since my discourse will be of light, I desire for it an unobstructed passage, because in the event of it being reflected or refracted, its power will be

the most sonorous bodies, and will work them into such forms, sizes, and conditions as will produce every peculiarity of sound; he will be sensible of a series of regular, agreeable sounds, producing *melody*, and an irregularity of them producing *discord;* he will be pleased with an intermixture of melodious sounds; he will arrange them into a *chord*—several of these chords will give him *harmony;* in the melody and harmony he will perceive an *interval* between the sounds, and this interval will depend upon the character of the sounds, whether high or low; hence he will derive *tones* and *semitones*, from these he will obtain a *gamut*, and a certain number of tones and semitones make an *octave*. Since melody is produced by a regular succession of sounds, and the octave is a number of tones and semitones, the interval will be regulated by the relation of the sounds, and will be *ascending* or *descending* accordingly as a high sound precedes a low sound or *vice versa;* and when the scale is extended in the ascent, he will have an octave ascending, or the *double octave*, if still further, the *triple octave*, and so on. As each tone is two semitones, so when he raises or lowers a sound a semitone, he will have that sound *sharp* or *flat*. When he produces a chord of agreeable sounds they are said to be *consonant*, because these sounds coalesce among themselves; but when a number of simultaneous disagreeable sounds are produced, they are *dissonant*, because there is no coalescence of the sounds. With a theory of harmony, and

principles and rules of composition, by the ingenuity and invention of his exertions, and the preciseness and acuteness of his auricular nerves, he can produce *airs* or melodies, inspiring, thrilling, saddening, cheering, and in short expressive of every emotion of the human breast.

"He will be also sensible of vocal sounds; these he will distinguish as articulate and inarticulate, the former embracing the systems of sounds or words denominated *speech*, from which he will derive the language used among mankind for their wants, comforts and happiness; the latter embracing the unorganized sounds of the different birds, brutes, reptiles, and other animals—by which they give expression to their joy, pain and anger—though unintelligible to man to a great extent, yet wholly understood among themselves. He will learn the various dialects of language occasioned by the events, circumstances, and necessities of association. Philology will instruct him in the study of words and language, by which he can be acquainted with the laws, manners, customs, governments, literature, arts, sciences, and religions among mankind. He will become sensible of the euphony of vocal sounds, and their correspondence and concord with instrumental sounds—hence he gets songs, airs, melodies, and harmonies from words; he will also perceive the euphony and melody in the chirping of various birds and insects. In addition to the emotions which the concord of sounds will awaken in his breast, he

agents for the proper analysis of metals and ores; he will learn Mineralogy in order to distinguish the ores, as metals are sometimes so much disguised in their ores that it requires the greatest knowledge and nicety of procedure, since there is great difficulty of knowing them from their external appearance, and they are sometimes liable to be taken for one another; he will learn Metallurgy, since, besides the ores of metals, there are *mineralising* substances, chiefly sulphur and arsenic, either separately or conjointly combined with the metals, whereas ores are various earthy substances of different natures, and sometimes possessing metallic lustre; and to distinguish the *pyrites* which have a great resemblance to, and are almost always accompanying the ores of metals. His knowledge of Chemistry and Mineralogy will enable him to *assay* the different ores, after which he will *smelt* the ores, in order that he may obtain the metals for his various purposes. By experiments he will find *iron* the metal best adapted for his intentions; the ore of iron, by *calcination* and *fusion*, he will convert into what are called *sows* and *pigs* of iron, according to their size, but are in impure states owing to quantities of vitreous or earthy matter being mixed with the pure metal, however in this condition very useful for ordinary purposes. But he will require this iron in a more improved state; hence he will convert the cast-iron into malleable iron by the process of *forging*, which he will give the form of bars. Smelt-iron by fusion

with charcoal, or bar-iron by cementation with wood-ashes and charcoal-dust of bone, leather, hair, and so forth, will make him *steel*, which he will temper according to circumstances, and thus have the material for his tools, instruments, and implements which he will shape as best for his purposes.

"And he naturally turns to such substances upon which to use them; hence wood, for reasons before stated, will readily afford him material for fabrication and manufacture. He will learn Mechanics to ascertain the power of cohesion in wood and its material strength; hence he will learn Vegetable Anatomy in order to know the structure of various plants and trees, because he will perceive that some parts are more ductile than other parts. He will learn Botany to tell from the external appearance the plant or tree of the particular kind of wood or material he needs.

"He will find wood not so durable or substantial in works he would construct, therefore he will use stone and other materials. His knowledge of Chemistry and Mineralogy will teach him the stones preferable for building and other fabrications; his knowledge of Geology will teach him in what locality he can procure them in the greatest quantities, finest qualities, and with the least trouble; he will quarry them in such sizes and shapes as he thinks will answer his designs. He will discover that some stones have the property by intermixture with each other, and other pro-

cesses, of being made plastic and cohesive, therefore he will make glass, tiles, bricks, cements, concretes, mortars, and plasters, which he will find useful to his works, ornamental to his designs, and embellishments to his taste. Thus equipped with his tools and materials, with ingenuity and invention unbounded, industry untiring, with the pleasures of touch ever stimulating his exertions, and the pains of touch ever exciting his anxiety, he will gather around himself every luxury, and revel in the exuberance of delights. In addition to the materials upon which to develope his skill, he will discover forces by which his arts and manufactures will be accelerated, perfected, and advanced; the motions of fluids, action and re-action of bodies from resistance; the communication, velocity, concentration, and direction of motion; and, in short, all the mechanical properties of bodies. He will learn Physics to understand the effects of motion; he will learn Hydrostatics to learn the weight, motion, and equilibria of liquids; he will learn Hydraulics to modify and direct the motion of liquids; he will learn Pneumatics to understand the mechanical effects of gases upon solids and liquids; Optics to learn the mechanical effects of light; he will learn Mechanics in order to avail himself of motion, overcome the resistance and reduce the friction of bodies; he will invent engines, from the lever, wedge, screw, and pulley to the most complicated machines; discovering the power and use of Steam, he will adopt it to put

in operation his various machines, and thus save in himself much physical labor, economize his time, strength, and materials, and accomplish feats which his individual efforts would vainly attempt; he will learn Carpentry and Joinery to mould, fashion, shape, and construct his furniture, ornaments, equipages, houses, and other works out of wood; he will learn Masonry to do the same with stone. By his knowledge of Chemistry and Mineralogy he will analyse the soil; by his knowledge of Botany, Vegetable Anatomy, and Vegetable Physiology, he can tell upon which soils his plants will thrive best; his knowledge of Geology will inform him of the location of soils; his knowledge of Agriculture will teach him the art of disposing the soils to best advantage, in order to produce his vegetables and plants in largest quantities and in greatest perfection, and for the proper cultivation of them; his knowledge of Husbandry will inform him of the manner of rearing cattle, the management of the dairy, making butter and cheese, raising timber, and every article of home production. By his knowledge of Cookery he prepares and dresses his food in all its luxurious refinements, and dishes of great costliness and variety. By his knowledge of Animal Anatomy, Chemistry, Mineralogy, Botany, and the art of Tanning he makes leather for his various uses; and by his knowledge of Animal and Vegetable Anatomy, Animal and Vegetable Physiology, Botany, Chemistry, Mineralogy, and various mechanical

process of assaying them—the last from its scarcity and consequent costliness not used; but he will find in making large purchases that coins are too burthensome; hence he will resort to the system of Banking and Foreign Exchange, and their various ramifications. He will construct railways for transportation, adopt steam to propel his carriages upon them, and, when necessary, tunnel his ways through hills and mountains, and bridge them over streams and valleys; his experiments and his knowledge of Mechanics will inform him of the superiority of iron over other materials in works of his construction, hence he will need it in large quantities. His knowledge of Mineralogy will inform him of the properties of coal in smelting the iron ores, and also in working his machineries; his knowledge of Geology will inform him in what localities, in what quantities, in what qualities, and the least difficulty by which he can procure it; and his knowledge of Mining will inform him in what manner to obtain it.

"He will discover in travelling about from place to place the necessity of proper apparels, since in some places he will be exposed to extreme cold and in other places to extreme heat, and very often to changes in the weather; hence he will devote his attention to fabricate cloth, and he will seek the proper materials from which to work it. He will find various substances, different kinds of barks, gums, the soft down of the cotton-tree, flax, hemp, the web of the silk-worm, hair, wool, and skin of

animals. His preparations will be regulated according to the material. And in all his manufactures, there is none more interesting than the processes by which things, to all appearance so unseemly, are converted into articles of such marvellous texture and condition as to compete in finish the gossamer web, and withal so durable and useful; nor more ingenious and surprising than the complicated and wonderful machinery by which a weed is metamorphosed into yarn or thread—into cloths of various fineness and softness—into muslins and laces of the most beautiful patterns and designs. He will learn Tailoring to fit these materials into garments of the latest cut and fashion. He will learn Hattery in order to cover his head, and will give scope to his fancy and taste in devising styles, shapes, and sizes. He will learn Cobblery for the manufacture of boots and shoes for his feet.

"He will discover in different countries different regulations for their domestic government and foreign transactions; hence he will take Statistics for future reference; study Law and its several branches, that his conduct may be regulated; he will learn Commerce in order that his many negotiations may be advantageous; he will learn Political Economy that he may understand the nature, production, accumulation, distribution, and consumption of wealth. He will make with some countries Commercial Treaties, and with others he will form Offensive and Defensive Alliances. In

the course of time, by the alteration of conditions and change of circumstances, the treaties and alliances will become oppressive and disadvantageous to one or the other party; disaffections will be expressed; Negotiations will be entered into, Conferences held, and the arts of Diplomacy practised: but to no avail—War will be declared. Then he will study Military Tactics for the proper conduct of the war: he will learn Military Engineering, and the art of building fortifications, to entrench himself when necessary, and in order to discover his enemy's weakest points and to breach his enemy's battlements. His powers and faculties which were before exercised in devising plans of comfort and pleasure, will now be employed in designing modes of ruin and demolition, schemes, intrigues, and stratagems; his mechanical apparatus and machineries in working weapons of destruction; his furnaces and forges will now turn out cannons and mortars of stupendous sizes, and for diabolical execution; he will arm his vessels with them, and attack his enemy in his most vulnerable places. He will discover the power of gunpowder, and use it to discharge his instruments of destruction. As the inevitable consequence of war, there will be wounds and diseases of every description and order, hence he must discover means and modes of relief.

"He will learn Anatomy in order to know the structures of the human body; he will learn Physiology to know the functions they perform, and the

phenomena of life; he will learn Pathology to determine their abnormal condition; he will learn Medicine in its various branches to judge the symptoms, natures, and results of various fevers and diseases, to know the best treatment and remedies for them; he will learn Pharmacy, to know the art of preparing, preserving, and compounding substances for the use of medicine; his knowledge of Mineralogy, Chemistry, Geology, Mining, Metallurgy, Botany, Animal and Vegetable Anatomy, Animal and Vegetable Physiology, and various arts, he will find indispensable to his success in Pharmacy; he will learn Materia Medica to know the effects, virtues and properties of medical simples; he will learn Surgery to alleviate diseases, and cure wounds by instruments and external applications. In his researches he will become conscious of singular phenomena excited by Electricity; he will experiment with it in divers ways; he will discover means of exciting it by machines: he will construct batteries of various powers; he will make other batteries by which the effects of Magnetism and Galvanism may be combined with it; he will extend their influence for the purposes of his comfort, security, and health; and he will communicate by them with remote countries, and with remarkable despatch.

"Though vast may be his knowledge of the uses and properties of tangible bodies, that no dictionary of his language can give a nomenclature for, nor can describe the various works, mechanisms, and fabrications of his ingenuity and invention, still

his knowledge will be of one description—that of *effects;* nowhere will he discover a single *cause.* All his knowledge of tangibility being based on the sense of touch, he can tell its *presence* only; but why bodies are tangible, or why he feels tangible bodies, or how tangibility acts upon the *papillæ* of his skin, he has no means of determining. He may increase his experiments manifold, multiply his arts, mechanisms and manufactures greatly, extend his researches through every labyrinth and in every recess of the universe—he will find *effects* only, not one *cause* will he discover; hence you have wild dreamers and vain speculators on the earth, following an *ignis fatuus* when seeking the cause of tangibility and of touch.

"Let him now give all his attention to all the knowledge man possesses by the sense of sight; by his optic organ he will be sensible of color, form, motion, distance, light, darkness, and in short, all the visible properties of bodies; his intellect will be exercised in discovering their utility, in perceiving the orders of their relations, the traces of their resemblances, the points of their contrasts, and the lines of their connections; his reason and instinct will suitably adapt them for his comfort and happiness, and fully interpret their purposes. His organ of sight awakens in him the most inspiring sensations of his soul, the goal of distance ever urges him on with hope, the beauty of color and symmetry of form fill him with transport and delight, the grace of motion enrapts him by its vivacious-

ness, and the purity of light purges him of dross and feculence.

"The first thing of which he will be sensible, will be light; and he will also discover how indispensable it is for action to the optic nerves; and by the alternancy of day and night, he will trace the presence of light due to the sun; he will observe its change of position, and his curiosity will inquire the reason; he will notice another luminary performing similar revolutions, but he will find its periods different from those of the sun; and by repeated observations upon the movements of the shining bodies around him, and his knowledge of Mathematics, he will conclude that the movement of the sun is apparent only, but in reality that the sun is stationary, and that the earth and other bodies revolve about it, and that the moon is a constant attendant of the earth in its revolutions about the sun. He will observe, that sometimes during the revolutions of the various heavenly bodies, that they occlude one another; hence he will discover that the sun is the source of light, and that the luminousness of the other bodies is due to the reflection of the light from the sun. By observation, he will learn the times of the revolutions of some of the bodies, which he will find periodic—hence he will be able to predict the moment of their occultation. By his knowledge of Optics and his knowledge of other things he had previously gained, he will construct *a telescope* and other instruments, by which he will watch the movements of the heavenly bo-

dies; he will speculate upon their distances, composition, sizes, conditions, and other interesting things suggestive to his inquiring mind. He will combine his facts, speculations, and Mathematics into theories, which he will call Astronomy; he will notice the effects of light upon the earth; his organ of touch will acquaint him with the sensation of heat; he will see wherever the sun shines a ceaseless activity, which you so graphically described in your discourse of heat; and he will be forcibly struck with the wonderful phenomena around him. His inquiring and curious mind will seek to divine the reason and cause; he will explore every part of the surface of the earth; penetrate various depths in its crust; collect, analyze, and dissect substances; burn the *midnight* oil with untiring vigils and persevering industry, toil patiently, hope earnestly, believe firmly; sometimes cheered with a few glimpses of truth, he will redouble his efforts, until checked by insuperable obstacles; however, nowise daunted, he keeps on, adding researches to researches, making investigations and counter-investigations—but all to no avail. Do you wish the reason? [I here gave my nod of assent.] I did not, at the start, pretend to give you the *minutiæ* of man's knowledge: I only intended to take a survey of the principal parts, knowing the fullest details would, in no respect, conflict with my conclusions, but will illustrate forcibly the truth of them. The existence of the various physical phenomena, man learns by the means

of his corporeal senses, as I have just shown you; the reason of them will interest his inquisitive mind, and consequently he will exert himself to discover the cause of them.

"From what I have shown you, you will perceive that his many mechanical and industrial arts and pursuits cannot in any way reveal a single cause; because man, obtaining all his physical knowledge by the media of his five senses, he knows the *presence* only of odor, flavor, sound, tangibility, and visibility; hence he is conscious of *effects* only, and cannot, for that reason, be sensible of *cause*. By his organ of vision he is able to examine all visible things within his reach; he sees that the surface of the earth is uneven, some parts greatly elevated, and other parts much depressed; he will notice great irregularity in the condition of the soil, and by penetrating the crust he will perceive this irregularity more marked; he will notice strata in some parts uniform, in other parts, as it were, wrenched and broken; in some places he will see a particular stratum occupying different positions—sometimes above other strata, sometimes below, and sometimes greatly intermixed; he will discover that some portions of the crust appear to be alluvial deposits, some portions appear to be formed by combustion and fusion, some portions appear to be the remnants and eruptions of extinct volcanoes, some portions appear to be in process of formation by the lava of volcanoes continually issuing from their craters,

some portions appear to be elevated from internal forces, and some portions will appear sunken from the giving way of the interior of the earth, or the gradual cessation of internal forces. All these things will interest him; but since *effects* only are presented to him, and his five senses the only means of obtaining any knowledge of them, he can only conjecture and speculate concerning the reason of things being as they are. He will build theories upon a few facts which come under his observation; he will give self-satisfactory reasons, drawn from apparent probability, but continually conflicting with each other, and wholly inexplainable of the simplest phenomena around him. In making his researches he will find fossils scattered promiscuously in the different strata of the crust of the earth, which he will seize upon, pore over, and dispute about—conjecturing, because a coin, flint hatchet, pottery, gnawed bones, and various fossils of extinct species of animals have been found in caves or strata of the crust—that he can prove the antiquity of man, his contemporaneity with mastodons, and the age of the earth: he does not reflect that he sees effects, and nothing more. Following his *ignis fatuus*, he will meet various minerals, which he will collect and examine; noticing in some resemblances, contrasts, and irregularities. He will divide them into classes, according to some sensible properties—as earthy, inflammable, saline, and metallic substances: the earthy he will subdivide into calcareous, ponder-

ous, magnesian, micaceous, asbestine, siliceous, and argillaceous earths; the other classes in the same way, according to some sensible resemblance. After which, he will subdivide them according to some nearer sensible resemblance; then he will discover some properties among them—when, under some circumstances, they will exhibit an action and re-action among each other—for which reason, and the effects these properties will produce, he will give another nomenclature to them, and make new divisions and subdivisions of them. Among the various properties which he will thus discover, he will find some very useful in relieving bodily pain; this will give rise to a new nomenclature, and other divisions and subdivisions; then in applying these simples of Materia Medica, he will make other researches, in order that the proper uses may be made and the desired benefits may be derived. He will dissect various animals and vegetables in order to find their several structures. The body of animals he will divide into two parts—for instance, the common systems and common textures of the body; the former will comprehend the circulating, absorbent, and nervous systems; the latter, the cellular substances, adipose substances, muscle, skin, hair, cartilage, bone, tendon, serous and synovial membranes. He will examine their structure and distribution; he will study the skeleton of the animal and the anatomy of the particular parts, and the situation of them; he will learn the process of embalming, to

prevent decomposition of the body after death. He will examine the structures of plants; he will notice those organs of which vegetables appear to be principally composed; he will discover the elementary organs, such as the vascular system and cellular tissue; the combination of these organs will give the common textures which will be found in almost every part of plants; he will examine the different kinds of seed, to find the structures and the various transformations of them; he will examine the mature plant to trace the anatomy of the trunk, branch, and root; he will next examine the organs which spring from the several members—the bulbs, leaves, flowers, and fruit; he will notice the structure and distribution of the various parts. After which, he will investigate the internal arrangement and the functions of living bodies, the economy of their parts, the powers of preservation and propagation of species; he will discover their various food, and nourishment, and habits. He will then consider their abnormal condition, the effects of abuse and derangement of structures and functions: he will notice the symptoms and watch the progress and maturity of different ailments, disorders, fevers, and diseases of living bodies, in order to learn the proper treatment and the application of the best remedies to afford relief and effect cures: he will experiment with various animal, vegetable, and mineral substances: he will make various preparations, compounds, and decoctions of them; he will

watch the effects they produce; when he finds them salutary, he will apply similar mixtures to similar symptoms, and thus by his industry and experience he will be able to afford relief and effect cures. Still without a knowledge of a single cause—but by the knowledge of effects only. Even when he makes his zoological arrangements he deals only with effects—external appearance of animals: the same in his botanical classifications and descriptions; nowhere does he trace a cause. Then can you wonder that his midnight oil is burnt in vain? and that his industry, perseverance, and patience are futile? his hopes blasted? and his toils endless?"

I answered—"If I see the thing which produces a thing, am I not right in calling one the cause, and the other the effect?"

The Man of the Sun responded—

"Most assuredly."

I continued—"When I see an apple fall to the ground, then seeing the earth and the fallen apple there, I can say that the attraction of the earth was the cause and the fallen apple was the effect?"

The Man of the Sun replied—

"Most assuredly not."

I here remarked—"I am as equally surprised to hear you say so, as I was to find no heat on the sun."

The Man of the Sun replied—

"Be prepared for surprises, for you are now on threshold only: and when I lead you further

you will find your earthly convictions very thoroughly shaken. What proof have you of attraction of the earth causing the fall of bodies, and what is it? And are you sensible of it in any way?"

I replied—"I have no other proof for attraction of the earth causing the fall of bodies, than when I throw a body up in the air it will come back to the earth, hence I conclude that the attraction of the earth causes the fall of the body. I cannot tell you what it is, except a certain inherent power which I suppose peculiar to matter, as much so as the odor, flavor, sound, tangibility, or visibility of bodies. And I am only sensible of it by seeing the constant falling of bodies when thrown in the air, or unsupported by anything they fall to the earth."

The Man of the Sun said—

"Then, if I place before you a magnet and a needle, and allowing the needle freedom of motion, and you seeing the needle approach the magnet, you would conclude by the magnet attracting the needle, that the attraction of the magnet is the *cause*, and the approach of the needle its *effect;* for the same reason that you said the attraction of the earth is the cause of the fall of the apple. Suppose I held the needle fast, it would no longer approach the magnet. Do you not see that the *withholding of my hands* is just as *instrumental* in the approach of the needle, as the attraction of the magnet? And the *act* of bringing the needle in the vicinity of the magnet, was more efficient in the

consequent approach of the needle, than if the power of the magnet had been increased manifold. And with the apple—the rain which nourished the roots of the tree was more powerful in producing the fall of the apple, than any attraction of the earth increased myriad-folds; had there been no rain there would have been no apple to fall; and I could thus add instrumentalities indefinitely, which had more to do with the fall of the apple, than any attraction of the earth. And when you throw a body up in the air, the mere act of throwing the body up is more instrumental in the fall of the body, than any attraction of the earth. When you define attraction to be a certain inherent power peculiar to matter, as much so as the odor, flavor, sound, tangibility, and visibility of bodies—you err most egregiously. Can you smell, taste, hear, touch, or see attraction? You see motion, but not attraction—therefore, not being made sensible of it by any of your physical organs, how do you know anything of it? You have commended your knowledge as unimpeachable, reasonable, and evidently true, because derivable from and referrible to, the testimony of your senses. Then, what can you say of attraction, which you can not derive from nor refer to your senses? It is one of those confused ideas among the many you harbor in your mind, which you cannot define nor sustain with any reason; you must banish all such ideas, if you wish to attain the truth. Your assignment of cause is erroneous, which you place upon some antecedent

effect, which is wholly opposed to your definition of cause—AN EFFECT CAN NOT BE A CAUSE. Think for one moment what would be the consequence, if you are right in tracing the cause of a thing to something which could be made cognizable by the senses; then, for every effect you could find a cause; the cause which produces the effect can only produce similar effects, and all dissimilar effects would have dissimilar causes; hence, you would have myriads and myriads of dissimilar causes acting simultaneously around you; could you, under these circumstances, be able to trace that unity of design and sameness of purpose which are now so evident to you? The assignment of a separate cause for each individual effect, is the Heathen Mythology *modernized*. The Grecian pagans had some god or goddess to preside over each event, to whom they sang their pæans and burnt their offerings."

I replied—"Then you do not regard gravitation as the force which regulates the movements of the planetary and other bodies?"

The Man of the Sun answered—

"The law of gravitation is based upon the attraction of matter, and like all speculations it has an unsubstantial foundation, and consequently it needs *props*. When you reason upon the attraction of matter and build theories, keep them consistent throughout; when you have a law, let it be your rule. If the attraction of matter was true, you would have found out before now the tempera-

ture of the sun; the attraction of matter and the law of gravitation would have brought the universe so closely together, that your attraction of cohesion would be superseded; but in order to explain the revolutions of the earth and planetary bodies you suppose a state of things diametrically opposed to your attraction of matter and the law of gravitation, which is—two opposites acting in unison; you have a *centrifugal* and a *centripetal* force continually tugging against each other. If the law of gravitation be *universal*, how can it be possible for the existence of the *centrifugal* force, which demands a condition of the *repulsion* of matter? When you cannot swim and go beyond your depth, you must use *corks*, and when you go above the reach of your senses, you must use *props*."

I replied—"Your remarks will stir up the philosophers on the earth."

The Man of the Sun replied—

"I cannot help it. If the philosophers of the earth will build upon weak foundations, they should be wise and *stand from under*. There is but ONE *Cause* for all things; and *that* Cause is not sensible to the *physical organs*."

I replied to the Man of the Sun:

"The philosophers on the earth are fully aware of what you call *The Cause* for all things; and are fully convinced of their inability to satisfy their inquiries, or extend their researches beyond the innumerable effects which are spread before them in the multiform works of Nature; but by the means

of their observations and investigations they have noticed a regularity and uniformity in various physical phenomena, which have enabled them to predict with certainty the occurrence of natural events; and to discover laws which regulate them. Whether or not, as *instruments* of the Cause, they have perceived a *relationship* between antecedents and consequents; and from this relationship, they have argued *connections* efficient, material, formal and final. The theory of gravitation has been hailed as the *desideratum* of science, and is regarded as the most brilliant achievement of the human mind, by explaining the law of the Universe from a simple phenomenon; and from its applicability and essentiality to Astronomy, the science which has engaged the attention of, and has been enriched by, the master minds of the earth: not only from the grand field that it opens for the display of the matured and educated intellect, or from the interesting and inspiring subjects it presents for contemplation, but from the indisputable deductions, correct calculations, and evident conclusions of its principles. The theory of gravitation is so intimately connected with this science, that to prove the theory erroneous would be to strip from the science its greatest ornament and its most efficient instrument. In illustration of the truth of the theory and its importance to Astronomy, I will state that astronomers noticed that the orbit of Uranus was perturbed incompatibly with the attraction of the sun and the known planets accord-

panied by the Projectile and Deflective Forces. Although you may think that because man uses the various curves in his many mathematical operations, that he understands their nature and properties—yet, you will find that when you bring his mathematical knowledge under proper analysis, how utterly deficient he is of their nature and properties. I will consider his mathematical principles and analyze his deductions therefrom, when I come to treat of his mental knowledge. At the present time, I will examine so much of his mathematical knowledge as has any relation to Astronomy and Mechanical Philosophy.

"In Arithmetic, you have *zero* which signifies *no quantity*—and every quantity, however small, has an appreciable value distinguishable from zero or nothing; hence, the continual decrease of any quantity by divisions and sub-divisions, can never produce entire destruction of value—therefore, it is plainly evident that however far the divisions and sub-divisions be continued, *quantity* can never be reduced to *nothing* or zero. This fact is conformable to one of the most important laws of Nature, which is, *that destruction is impossible;* take any substance you choose, you can decompose that substance into its ingredients; and it may be possible to decompose the various ingredients into more elementary bodies, still nothing has been destroyed, for though the bodies be further resolved into gases, and the gases be reduced still more to ethers—it is still within the province of Nature to re-compose

earth, in the acquisition of knowledge, I have not failed to notice the tendency of their thoughts, the development of their intellect, and the exercise of their reason. Placed as they are, with physical phenomena acting and re-acting around them, and perceiving a regularity and uniformity in the phenomena, they are urged on to a knowledge of them by the requirements of their condition, at the same time, stimulated by a spirit of emulation, and elated by congratulations upon their achievements, it is natural for them to interpret to their own satisfaction the various phenomena with which they become acquainted; to give explanations to laws which they conceive regulate them; and to assign reasons and causes for their existence. But limited as their facilities of knowledge are; with a contracted field for the display of their faculties; with the existence, relations, actions and re-actions of effects only presented to their consideration; with their corporeal senses the only *media* of their knowledge; and with prejudice, ignorance and darkness the concomitants of their investigations, it is not to be expected that they can surmount such insuperable impediments, penetrate the multitudinous labyrinths of the Universe, or unravel the *gordian knots* which bind the mysteries of nature. Yet, in spite of these obstacles, there are persons on the earth presumptuous enough to expound laws for the Universe, and give reasons and causes for the various physical phenomena. But be it said for the glory of philosophy, there are *philosophers* who

are wise enough to acknowledge their ignorance of things beyond the spheres of their senses. I will strengthen these remarks when I treat of the mental knowledge of man.

"I will now consider your other rejoinders. You regard the theory of gravitation as the most brilliant achievement of the human intellect; as the greatest ornament and the most efficient instrument of Astronomy—which science you laud as the *acmé* of truth. I have no desire to deprive the philosophers of the Earth of one *iota* of their knowledge; but I will justly criticise their efforts for knowledge; give them credit for what they really do know; and show what they do not know. When you know what Astronomy *is*, you will not be so anxious to uphold the indisputable deductions, correct calculations and evident conclusions of its *principles*. The term Astronomy, you know, means *the law of stars;* but really, the knowledge obtained by astronomers, is simply the *observations of sidereal bodies in regard to their movements in space, and other phenomena;* and so long as their attention is directed to *facts obtained by observations*, then the deductions are indisputable, the calculations correct, and the conclusions evident; but so soon as their attention is directed to *hypotheses for laws which govern the celestial mechanism*, then the deductions become fanciful, the calculations become extravagant, and the conclusions become chimerical. What you call the *principles* of Astro-nomy, are not derived from facts, but from hypo-

theses; hence, the deductions, calculations and conclusions, are unreliable, when derived from those principles. Observations give facts, while hypotheses give principles, laws and causes. The facts of Astronomy have been collected by innumerable observations, accompanied by indefatigable labor, perseverance, industry and patience. Man has been made acquainted with the existence of cosmical bodies by reason of their visibility, tangibility, sound, flavor, and odor. But since his acquaintance with astronomical bodies is confined to the organ of sight, man can know the visibility only of astronomical phenomena; hence, his knowledge of them can be obtained by observations only. In remote ages, the astronomical phenomena had interested the human mind; the movements, changes of position, and various circumstances attending the celestial bodies, excited the curiosity and occupied the mind of man—not idly, but from apparent as well as absolute connections with terrestrial phenomena and human affairs. Thus incited to a consideration of astronomical phenomena, the knowledge of man became enriched by observations with interesting and important facts. But so prone is the human mind to indulge in fancy, that, ascertaining the movements and other circumstances of celestial bodies, man grouped them in forms of beasts, reptiles, birds, and other terrestrial objects, and conjectured powers which upheld them, forces which impelled them, and delineated paths for them through the expanse of space. I will not detail the

various facts of astronomers, nor give the tedious operations by which they were obtained, except so much of them as are necessary to show what use and importance the theory of gravitation is to Astronomy. Man's first astronomical investigations were directed to the apparent movements of the Sun, and the movements of the Moon, being the most prominent objects, and exerting great influences upon terrestrial phenomena. The vicissitudes of day and night; the regular appearance and disappearance, and the phases of the Moon; the periodic returns of the seasons; and the reciprocal occultations of the Sun and Moon, were common to the most casual observers; but when attention was directed to them, irregularities were noticed in these occurrences—then, *causes* were sought, and reasons were assigned for them. An orbit was given to the Sun, upon which it was supposed he performed an annular revolution around the Earth. This path was called the *Ecliptic*, an imaginary circle in the heavens which equally divides twelve constellations, or clusters of stars, call the *Zodiac*; to the Ecliptic are referred the longitudes and latitudes of the heavens. Another imaginary circle, called the Equator, or Equinox, is supposed to intersect the Ecliptic obliquely—the angle of intersection is called the *obliquity of the Ecliptic*: by this is accounted the vicissitudes of the seasons, and the inequalities of the days and nights. Eclipses of the Sun and Moon occur when Moon is near the Ecliptic. By observations

lines. Hence, the circumference of the circle shows how the equality of *straight lines* can be always constant. The hyperbolic curve shows how the difference between two varying *straight lines* can be always constant; the elliptic curve shows how the sum of two varying *straight lines* can be always constant, and the parabolic curve shows how the equality of two varying *straight lines* can always be constant. Whilst to form the algebraic equation of the circle, the geometer uses the relations between *straight lines*, viz.: the *abscissa* and *ordinate* of a point in the circumference, and from the same *rectangular co-ordinates*, he forms the polar equation of the circle, whilst the algebraic equations of the hyperbola, ellipse and parabola are formed from the relation of certain *straight lines* drawn in or about those figures, and their polar equations are also derived from the system of *rectangular co-ordinates*. The transcendal equations of curves are similarly derived as the algebraic, but they are expressed differentially. The exponential equations of curves are intermediately between the algebraic and transcendal equations, where one or both of the unknown quantities enter as exponents, and are the methods of performing algebraic operations on exponential quantities. Hence, all the equations of the circle, ellipse, hyperbola, parabola, curves of double curvature, and curved surfaces are formed from the properties of *straight lines*. Since Elementary, Analytical, Descriptive and Perspective Geometry, the Algebraic Analysis, the

evection of the Moon; the eccentricities in orbits —these are the most prominent features of astronomical phenomena, which being obtained by observations, are astronomical facts; and constitute practical Astronomy, and entirely independent of the theory of gravitation, the Ptolemaic, Copernican or any other system of Astronomy—being based upon the apparent movements of the celestial bodies, repeated and careful observations, and properly adjusted and appropriate instruments. The reason is evident, since astronomical phenomena are perceived by observations, and observations being the *criteria* of correctness, most certainly *appearances* must be the ground-work of reasoning. Hence, observations, not theory, the procedure of astronomical investigations. Eclipses were predicted before the age of Ptolemy—the solar and sidereal years were known anterior to Hipparchus, who is regarded the father of Grecian Astronomy: thus, you see that some of the most important parts of practical Astronomy were calculated without the aid of the theory of gravitation, as the prediction of eclipses and the knowledge of the difference between the solar and sidereal years, evince an acquaintance with the *essentials* of Astronomy. By reason of the unaided vision, astronomical knowledge was contracted to a narrow field; therefore, the movements and some circumstances of the Sun, Moon, a few planets, and the situation and position of clusters or con-ellations of stars, constituted what was known

before the Telescope was invented. Fanciful ideas were commonly entertained concerning powers which upheld the Earth, and forces which propelled and sustained the various heavenly bodies through space; paths were traced for them—some dignified by the name of systems: the most prominent at one time, known as the *Ptolemaic*, which imagined the Sun, Moon and planets to proceed in uniform motion around the Earth upon the circumferences of epicycles, the centres of these epicycles to move also uniformly on the circumferences of *deferent* circles. These deferent circles being the epicycles of other deferent circles, and so on until all inequalities were removed—the Earth occupying a place near the centre of the last circle. In addition to the ingenuity of invention, the ratio between the radii of the epicycle and its deferent was demonstrated, also the velocity of the planet and the velocity of the centre of its epicycle. Here you see the tendency of thought when loosed from facts and adrift with hypotheses. Another attempt was made to explain the apparent movements of celestial bodies, by supposing the Sun the centre of the planetary system, but occupying a position little distant from the common centre of the orbits of the planets, giving the Earth a triple motion—a rotation upon its axis, a revolution about the Sun, and an axial motion, and regarding all the orbits *circular*. This system is known as the *Copernican*. Another attempt was made to free hypothetical Astronomy of inequalities by imagining that the

Sun moves around the Earth, and at the same time, the centre of the planetary orbits. This is the *Tychonic*. Another attempt was made to explain astronomical motions by supposing the earth and planets to revolve around the Sun upon *elliptical* orbits and the sun to occupy a place near the common focus of the orbits. The satellites to revolve around their respective planets also in elliptical orbits. The curve of the Ecliptic to be also elliptical. Giving the Sun a rotary motion upon its axis and a revolution around the common focus upon an elliptical orbit—this last motion is supposed to be occasioned by the revolution of the whole sidereal heavens, ignoring the idea of 'fixed' stars, maintaining the rotary motion of the earth upon its axis; and reasoning upon the *inertia* of *matter* asserting the parallelism of the earth's axis, thus denying the axial motion of the earth, supposed in the Copernican system. This is the *Keplerian* system; it is adopted at the present time, and it promises to hold until some better system is proposed.

"And when I spoke of the Sun being regarded stationary, it was in view of the difference between the words *fixed* and *stationary*. The Sun is not 'fixed' in regard of the Keplerian system; but stationary in relation to the sidereal heavens; however much the Sun may be regarded as revolving around some centre, still it has its *station* near the common focus of the elliptical orbits. Seeing the tendency of bodies to fall to the earth when un-

supported, man conjectured supports and powers for celestial bodies. At one time believing the firmament a great vault, and the stars *holes* therein, through which the fiery element which was believed beyond shone, while the sun, moon and planets moved in grooves in the firmament, and the Earth upheld by monstrous dragons. Refining his ideas, he now imagines *forces* efficiently upholding, impelling and regulating the celestial bodies in their diversified movements and positions. I want you to notice the difference between Practical and Hypothetical Astronomy. The first takes things as they *are*—the other considers things as they ought *to be*. The first, beginning with observations, and regulated by observations, consequently agrees with observations; the other, based on hypotheses, controlled by conjectures, must be altogether ideal and at variance with facts; hence, you see the strenuous efforts, the multitudinous explanations, the countless arguments, the endless reasons, whys and wherefores, to give it the *air of probability*. The first relates to common occurrences—therefore, useful and applicable to the ordinary transactions of human affairs. The other, the product of idle curiosity, sows the seeds of fancy and imagination, and is only appropriate to instil in youthful minds the rudiments of mathematics, and exercise them in mathematical formulæ and deductions. The first is the problem of *time*, and expresses from any given instance, the position of any of the visible heavenly bodies in the past or

culations derived from the recognized rules and principles of Astronomy, and made by the most distinguished astronomers of the present age; when I come to treat of man's mathematical knowledge, and investigate the rules and principles of Astronomy, you will discover what amount of faith you can place in the deductions, calculations and conclusions of those rules and principles. Instead of the perturbations of Uranus confirming the theory of gravitation, you will find them, on reflection, the consequence of another circumstance and not of the *attraction of matter*. When astronomers observe the motion of other planets, they discover certain *stations* and *retrogradations* in their orbits, which they attribute to the position of the Earth; they reason that, when the Sun is regarded the centre of the planetary movements, these irregularities are annihilated. But those of Uranus were so great that the history of Astronomy could afford no precedence; it was therefore adjudged that another planet revolved outside the orbit of Uranus. You have seen with what correctness astronomers calculated the elements of that planet, and can you say that the theory of gravitation has added anything to Practical Astronomy? If the irregularities of Uranus had no precedence in the history of Astronomy, they are owing to the great distance Uranus is from the Sun—much greater than any other then known planet. Had astronomers considered this fact, and the incorrectness of their calculations;

and had also referred the perturbations to the consequence of the position of the Earth, and had regarded the Sun as the centre of the planet's movements, these perturbations could have been explained without appeal being made to the "attraction of matter" and the "law of gravitation." Astronomers have calculated the distance of Uranus from the Sun as 1,800,000,000 miles, and they have also calculated the distance of Neptune from the Sun as 2,850,000,000 miles, and its mass $\frac{1}{2,000}$ths of the Sun. Now, can it be possible, allowing an attractive force to matter, that a body so small in proportion as Neptune is to the Sun, and situated at a distance from Uranus of 1,050,000,000 miles, could disturb the motion of Uranus when under the influence of the Sun at the distance of 1,800,000,000 miles? If so, then the law of gravitation that bodies attract each other directly as the mass, and inversely as the square of distance is plainly inconsistent. Let me now call your attention to the merits of the theory of gravitation. It has been a long recognized fact among philosophers on the Earth, that a species of attraction exists between what they call the *molecules* of *matter*, whereby heavy bodies fall to the ground and light bodies ascend in the air; and, in short, that which gives activity and motion to everything around them. These phenomena being so common and so necessary to their existence, were, naturally enough, incentives to their curiosity, and afforded employments to their intellect and reason. But,

owing to the condition of man, and the reciprocal relations existing between the links in the chain of antecedents, which I can more pertinently explain when I come to treat of his mental condition; the explanations which philosophers gave for these phenomena were characterized by a uniformity of ideas, and a similarity of conceptions, which showed more the fertility of their imagination than the legitimate exercise of their judgment. Conscious of effects, they continually perplexed themselves with the nature of cause. Theories and speculations beyond number were dreamed, thought, promulgated and disseminated by them from the earliest history of man. Many of these theories and speculations have been in turn approved and admired, until from a modification of terms and a prevalence of other definitions, they have been refuted and condemned, and have given place to other theories and speculations differing in technicalities and the applications of principles, which await at the proper time a like fate. Since the errors which have been made palpable in the one are ingeniously concealed in the other; and when the mind of man breaks the yoke of prejudice and ignorance the errors are discovered and exposed, to be again sophistically disguised, and in this manner the mind of man is swayed and controlled by his ignorance and prejudice, and when he thinks himself on the highest stage of intellectual advancement, he is tottering at the precipice of mental darkness.

"The theory of gravitation is no modern growth, but its roots extend to remote ages, and its incipiency can be traced amid the rude notions and absurdities of the pristine developments of human reason, when the worship of man displayed itself in the adoration of wood and stone and the deification of matter. The progress of man is gradual, and is marked by the shedding of scales of particular errors and prejudices, not by a sudden illumination of the general darkness; hence, from the relations of antecedents, and the dependent condition of man, his mind must long be tinctured with his earliest ideas and conceptions, which engraft themselves upon his maturer thoughts, and in a great degree influence his reflection and affect his judgment. And thus, the theory of gravitation cannot be considered an *excrescence* of human reflection; but it is a *natural development* of the human reason, exhibiting the imperfections of the human intellect. For the application of the theory of gravitation, it is necessary to regard the 'attractive power of matter' as being in the *centre* of bodies, and that there is a reciprocal attraction between the 'molecules of matter;' also, that this attraction is regulated by a law—showing that the 'attractive force' is directly to the mass and inversely to the square of distance. Hence you see the hypotheses upon which the theory is based, and without the admission of the hypotheses the theory can have no existence, and when you admit the hypotheses, you subscribe some of the rankest absur-

dities of which the human mind is capable of conceiving. Now, the existence of such a force in the *centre* of bodies is physically impossible; for the centre has no physical existence, being an imaginary point, and cannot admit of extension; because, if it did, there would be some parts of the centre not in the centre. And as no force can proceed from an imaginary point, there cannot be any real or positive effect. That there is a *power* controlling the movements of bodies, is indisputable; but when man endeavors to explain their various movements by *Central* Forces, he unwittingly entangles himself in such a net of perplexities, that his reasons become whimsical and his arguments to no purpose. In order for a correct interpretation of the movements of bodies in space, it is necessary not only to know *why* and *how* the power acts, but *whence* the power is derived. In the *theory* of gravitation, the centrifugal force is omitted; but in the *application* of the theory a small decrement is allowed for it to the force of gravitation, while the demonstration of the theory is conducted by a reasoning antagonistic, and diametrically opposed to the theory of Central Forces; and in this case, no reason is assigned how bodies in space maintain their positions at such distances from each other. Man *seeing* that all terrestrial bodies fall to the Earth, but ignorant of the reason, conjectures that this is the condition of all bodies in the Universe, and endeavors, by experiments made upon the times of ascent and descent of terrestrial objects, to affix laws

regulating the movements of bodies in space. Unless he knows *why* objects fall to the Earth, how can any credence be given to his explanations concerning the circumstances attending the bodies remote from his sphere? In the well-known fact of a *coin* and *feather* falling together in an exhausted receiver, you can at once see, that the *mass* of bodies has no preponderance over other properties of bodies. As you cannot say that the *mass* of the coin is equal to the *mass* of the feather, and though in the air, the coin will fall quickly to the ground, while the feather will float away—still, when the air is excluded from them, they will both fall together, and at the same time. And where then is the *gravity* which forms so conspicuous a part in the interpretations given by philosophers for physical phenomena? Ignorant of things which are presented to his daily observations, he attempts to explain the condition of things which are beyond his reach. Hence, the reason is plain why his analogies are inconsistent, and his conclusions are impracticable. When man speaks of the 'attraction of matter,' he oversteps the limits of his senses; for of matter he has no knowledge. A rose is fragrant, but he cannot say that *matter* is fragrant, although he considers the rose *composed* of matter; a rock is also regarded *composed* of matter, still it is not fragrant. The loadstone attracts iron, but wood does not—both are regarded *composed* of matter; hence, it is not the *matter* in the loadstone which attracts. That *fragrance* of

which man is made sensible by the organ of smell, is as much the property of the rose as the hardness, shape and extension are the properties of the rock, of which man is made sensible by the organ of touch.

"The *presence* of matter is learned by any of the organs of sense; thus, flavor is as much matter as any of the tangible or visible properties of bodies. What does man know of flavor except its presence? What does man know of tangibility except its presence? Hence, what does man know of matter? And being thus ignorant of matter, how can he say that the *molecules of matter* attract each other? Do the *molecules* of flavor attract each other? Or the *molecules* of odor attract each other? Or the *molecules* of tangibility attract each other? Or the *molecules* of visibility attract each other? What are the *molecules of matter?* They exist in the imagination only of the human mind. By experiments man has found certain things which are the components of bodies; he has discovered a certain regularity in their admixtures, and certain properties which are peculiar to ingredients and their compounds. These properties do not belong to *matter;* but are the peculiarities and characteristics of simple and compound *bodies.* In his chemical analysis, to facilitate his operations, and systematize his experiments, he first reduces chemical phenomena to simple and compound bodies. Among the first, he regards those bodies which cannot be resolved into more simple bodies,

such as oxygen, simple combustibles, metals, earths, caloric and light; among the latter, he regards those bodies which are formed by two simple bodies; those formed by a simple and compound body, or two compound bodies; and those which are presented in Nature, as mineral, vegetable and animal substances. The compound bodies formed by two simple bodies are known as water, alcohol, oils, alkalies and acids; those formed by two compound bodies, are soaps, a compound where oils enter without decomposition; neutral salts, a combination of acids with alkalies, earths, or metallic oxides, and those mineral, vegetable and animal substances which belong to the departments of Mineralogy, Zoology and Botany; giving the external description, the internal composition, the analysis of the various ingredients which form organic and inorganic substances, inferring the manner of combination and process of formation, and changes.

"This interesting part of his knowledge is entirely due to *experiments;* and demonstrates very forcibly the utility and importance of *empirical* Philosophy; at the same time, you cannot fail to see that his products are greatly circumscribed—being invariably characterized by a *binary* composition, such as exist among *inorganic* substances; and he is absolutely unable, from the complexity of ingredients, to re-compose *organic* substances. Inorganic substances exhibit a stability of combination not susceptible to organic substances; the latter under-

going continual changes, and the equilibrium of the composing elements easily destroyed from the slightest circumstances. The manner in which chemical compounds are formed, or the phenomenon of chemical affinity has interested man very deeply; he conceives that it is a species of attraction—a *drawing* of the particles of a body together, and by which they are kept united. As long as he confines himself to facts, he increases his knowledge, strengthens his understanding and exerts his reason; but facts are obtained by the senses only—hence, that moment he deserts them and endeavors by fancy and imagination to investigate physical phenomena, he enters the domain over which his intellect can recognize no jurisdiction, and through which his reason can afford him no guide. Chemical affinity is not the *attraction of the particles of a body for each other;* because, attraction implies contact only of the particles—as the *cohesion* of homogeneous bodies, or the *adhesion* of heterogeneous or homogeneous bodies; whereas, chemical affinity is the *saturation* of one body with another body, and requires the heterogenity to produce the chemical union; whilst there must be an homogenity to constitute attraction. The mere *contact* of the particles of a body is not a *chemical* union; but it is a *mechanical* condition. In chemical language, *solution* signifies *saturation;* yet, there is not a distinction only but a *difference* in the terms; when bodies saturate each other, so long as they are saturated, they lose their peculiar

properties, and they form a body different in *kind* from the component bodies; but when a body is held in solution by another body, they form a body different in *degree*, and no *chemical* compound. A solution is the *mixture* between a fluid body and a solid body; by evaporation the fluid is dissipated, and the solid remains unchanged in its properties —evaporation being a *mechanical* process, the *solution* is no *chemical* union.

"In chemical compounds there is a unity, identity or sameness in every part; one *atom* of the compound agreeing in nature and properties with every other. The *contact* of one atom of a body with the atom of another body can not produce *chemical* union; because the atoms having contact only still retain their peculiar properties, and do not *saturate* each other; whilst in chemical union the atoms lose their distinctive features, and become *blended in each other* by saturation; and thus remain until decomposed by other chemical unions, or precipitated with their original properties. So that the *Atomic Theory* is at variance with facts. Man having no guide in his researches and investigations of physical phenomena except his senses, it is impossible for him to discover anything beyond their cognizances; hence the *effects* of chemical action constitute his chemical knowledge, while the *procedures* of what he is pleased to term chemical affinity, molecular attractions, adhesion of surfaces, and cohesion of particles, decomposition, precipitation, fermentation, saturation, putre-

faction, galvanism, magnetism, and electricity, are beyond the reach of his earthly state. As an illustration, take the various combinations of oxygen and nitrogen, and you have the *protoxide* and *binoxide of nitrogen, hyponitrous, nitrous* and *nitric acids*, and in a state of mixture oxygen and nitrogen form *atmospheric air*. In symbolic Chemistry these are regarded as so many equivalents of oxygen and nitrogen united, or so many *atoms* of them chemically combined. Analysis reveals the proportion of the ingredients, they are not nitrogen combined with the certain equivalents of oxygen, but one equivalent of the *protoxide* saturated with one equivalent of oxygen to compose the *binoxide of nitrogen* or *nitric oxide;* one equivalent of the *binoxide of nitrogen* or *nitric oxide*, saturated with one equivalent of oxygen to compose the *hyponitrous acid*, and so on. Hence; you see, that though the *binoxide of nitrogen* or *nitric oxide* is composed of two *elementary* bodies, it is not composed of *simple* bodies: as the *protoxide of nitrogen*, or *nitrous oxide* is a compound body. Therefore, you see the *Atomic Theory* is incapable of explaining the *manner* as well as the *process* of chemical combinations. Man regards caloric and electricity as inducive to chemical union; the first is the scientific name for the power of heat, to distinguish it from the sensation of heat. I have already shown you that caloric or heat is not understood by man, and consequently, he is unable to give any explanation of its opera-

tions, from the fact that he can know its *presence* only—and that his sense of touch can give no insight into its nature.

"When I come to treat of light, I will explain to you what heat is, and what share it has in the economy of nature, which will be when I have presented to you the *outlines* of the *physical, mental,* and *moral* knowledge of man. And now I will discuss man's efforts to gain a knowledge of electricity. By the term *electricity,* is embraced the phenomena occasioned by *friction; by the connection of the muscles, sinews, and metals, and the influence of the loadstone.* Though these different things produce various results, yet in kind they are alike, depending upon the means by which the electricity is produced, and the various modifications of the phenomena. Man's knowledge of electricity is entirely *empirical,* and can be extended by experiments only; and in no wise can the theories he invents account for the nature, law, or character of the phenomena; for the reason that the experiments man makes are altogether dependent upon the phenomena themselves; and these phenomena he learns by his senses, and are entirely *effects,* and of these *effects* he knows their *presence* only; hence, how these effects are produced, what law regulates them, or any insight into the nature of these effects, is entirely beyond the *surveillance* of his senses. The theories he invents are based upon effects, and are derived from the few facts with which he is

the abstruse properties of Truth and Falsehood; the Goodness, Mercy and Love of a God; and the Wickedness, Sin and Hate of a Devil. And, according to his condition, and suitable to his circumstances, these Religions will assume phases indicative of his progress in civilization and enlightenment. With a further advancement in refinement and education, he adopts Theologies which teach the existence, character and attributes of one God, his laws and government, the doctrines to believe and the duties to practice.

"Again, with a subtilty of conception, he ignores the tenets and dogmas of Revelation, and endeavors to trace, from the relations of consequents to antecedents, physical causes for the multiform phenomena and works of Nature; and, reasoning *à posteriori*, from the unity and sameness of action, the evidences of design, and the indications of intelligence, he deduces *one primal cause*; but, being unable to personify this cause by the sophistry of Atheism, he launches off in the sea of uncertainty, and embraces the notion of *chance* to account for the innumerable things and complex operations of the Universe.

"I have made this digression, to show how easily the mind of man is influenced, how he seeks, in the appearance of things, the interpretation of their mysteries, and how the appearance of things exerts over his thoughts a sway which encourages his imagination. That two opposite powers exist, is a fact which needs but little research to discover.

Everywhere you see evidences showing the changes which occur in obedience to them; but what these powers are, man has never explained, and, in fact, never understood: his numerous expositions have been vague guesses; yet, contented with a reasoning, though failing to convince, he has built theories grand in his own conceptions, but inapplicable to the ordinary and legitimate operations of Nature. By his experiments, he has discovered two kinds of electricity; but, to gain any insight into their nature, he has been much circumscribed; hence, you see why his conclusions are unsatisfactory. That there is a congeniality between them, has never been discovered by experiments; and for attraction to exist without this congeniality, is at variance with the nature of things.

"Electricity is liberated either by friction, pressure, percussion, chemical action, or whatever disturbs its equilibrium in bodies; from vitreous bodies is liberated the positive or vitreous electricity, while from resinous bodies is liberated the negative or resinous electricity, although, from various circumstances, vitreous electricity has been derived from resinous substances, and *vice versa*. He noticed that vitreous *electrics* repel substances vitreously electrified, but attract substances resinously electrified, and *vice versa;* hence arises the law of electricity, that similar electricities repulse and dissimilar electricities attract each other. When man prescribes a law, it is proper to expect that he sees the point of its application, and the force of its

action; because its efficiency is derived from its practicability. And if evidences exist of his wrong interpretation of the state of things, then the aphorism loses its character of a law, and becomes a surmise. And it is very questionable whether man can limit the actions of phenomena, when he is laboring under an ignorance of their nature, and has no knowledge of their *modus operandi*.

"Electricity *in motion*, or galvanic currents, is one of the modifiable states in which electrical phenomena present themselves. It is discovered by man to be ready formed and awaiting, by proper connections, a development of its properties. Chemical action is attributable to this state of electricity, as exhibited by the *Voltaic Battery*. The requisite conditions for these phenomena are, a generating metal, or a metal chemically acted upon, a conducting metal, and an intermediate fluid possessing the capability of conduction and the properties of an *electrolyte*. According to the nature of electricity, galvanism exhibits two currents manifesting similar properties to the two kinds of electricity already stated, and consequently receiving similar names. The largeness of the plates of metal will increase the quantity of the electricity, and the numerousness of them will increase the intensity. In the latter case, when the *electrodes* are removed a little apart, a brilliant current of fire is produced, unendurable to the eye, capable of overcoming obstacles, and being conducted in a way not susceptible to the electricity of the frictional

machine, of pressure, percussion or other mechanical means.

"Though so powerful and energetic, the electricity is incapable of penetrating the thinnest non-conducting substance, as is often done by the electricity of the *Leyden Battery;* but by a little salt and moisture on the hands, the non-conducting tendency of the skin is overcome; and if the body be made a part of the current, a continuous shock is felt.

"By the same means, metals of silvery lustre, so light as to float on water, and very inflammable, have been discovered in the alkalies; wires have been ignited, metals burned, combustibles exploded, magnets and thermoscopes made, galvanometers affected at great distances, rocks blasted, gunpowder exploded under water, and telegraphic signs communicated with exceeding velocity and to remote distances.

"In addition to all these, the Voltaic battery has been made the means of chemical analysis—metals oxydated and dissolved; water decomposed into oxygen and hydrogen gases; neutral salts, when in solution, decomposed, the acid portion accumulated at the *anelectrode*, while the basis, whether earthy, alkaline or metallic, was transferred to the *catelectrode;* the elements of compound bodies conveyed through solutions of substances without any chemical effect being produced; minerals and other substances have been formed; the sensations of sight, taste and touch produced; while its physio-

logical effects have filled man with astonishment and wonder. When a galvanic current is made to pass along a nerve connected with any of the voluntary muscles, the latter are convulsively contracted; and when galvanism is applied to animals after death, so long as their muscles retain their contractibility, the convulsions are so striking that the animals seem restored to sensations, and suffering the most excruciating pains and tortures; their eyes open and shut, their nostrils vibrate, and their jaws undergo the process of mastication; and the galvanic influence, when transmitted through the lower portions of the divided *par vagum*, restored the secretion of the gastric juice, and the digestion of the contents of the stomach.

"In the department of Medicine, galvanism has been applied with salutary effects in cases of nervous disorders and complaints, and other diseases. In the Arts, galvanism has kept pace with the necessities of man, by the process of *electrotyping*, duplicates of medals, coins, seals, plaster casts, engravings, and copies of almost any substance can be taken with little expense and in great numbers. Electricity, *at rest*, or Magnetism, is another of the modifiable states of electricity. It is discovered in the steady position of the magnetic needle, which is subject however to variations in declination, inclination and force, owing to circumstances not fully investigated by man. His knowledge of these phenomena is confined to a few experiments; and like other departments of his science, he has diges-

ted a code of laws based upon imperfect *data*, because of inefficacy in his mode of procedure.

"The influence of magnetism extends over the surface of the Earth; but its indications are different in different places, and exhibiting three kinds of phenomena, known as the *isodynamic*, *isoclinic* and *isogonic*, which are differences of degree, and depending upon locality in reference to the magnetic *poles* and *equator*. Hence electricity *aroused*, electricity *in motion*, and electricity *at rest*, are the three modes of electrical phenomena known to man. And in these three states, electricity preserves its nature, though exhibiting different phases; in each state are observed two kinds with characteristic properties, as are shown in vitreous and resinous substances, the anelectrode and catelectrode of the Voltaic Battery, and the north and south poles of the magnet; while the law of attraction and repulsion, which has gained so readily the assent of philosophers in their experiments on electricity excited by friction and other mechanical means, cannot be enforced with impunity in magnetism; for here in the *poles* of the magnet is exhibited the phenomenon of the two kinds of electricity seeking the extremest distance from each other; and though the different poles of the magnet appear attractive when brought together, and the similar poles of the magnet appear repulsive when brought under the same circumstances; yet the three powers of terrestrial magnetism—declination, inclination and intensity—when acted upon by

resorted to the accurate mode of finding the length of a pendulum which makes a certain number of oscillations in a given time, since the intensity of the force of gravity regulates the number of the oscillations. The elements of the equation expressing the *desideratum* are as follows, namely: gravity equal to length of pendulum multiplied by the square of ratio of circumference of circle to its diameter. This equation gives *twice* the space passed through in the given time; consequently, *one half* will be the space passed through: a small part of this is counteracted by a repulsory force: this diminution constitutes it what is properly *gravitation.*

"This force, being directed from the centre of the earth, becomes more intense the nearer the centre is approached, which is shown by an increase in the number of vibrations of the pendulum, and the figure of the earth is thereby determined; since, the number of vibrations is, in a given time, as the square roots of the forces of gravity. But this determines the intensity of gravity at or near the surface of the earth; and the philosophers, conjecturing that this force is exerted upon bodies at remote distances, it became necessary to discover some law according to which its intensity is diminished. The hypothesis, that gravity acts proportionally to the inverse ratios of the squares of the distances, was confirmed by the measurement of a degree of latitude on the surface of the earth. When this law is applied to the Moon, it was found

among the particles of bodies, and the tendency of masses to approach each other.

"They have conceived it to be an impulse of some *force*, the nature of which they have regarded beyond their cognizance; but shown by decompositions, new combinations and coherence among molecules and motion among masses. Owing to the insensible distances between the minute particles of bodies, the former species of attraction has never been investigated by the philosophers; the motion of separate masses to each other, however, has come more under the jurisdiction of their senses, and consequently their researches have met with more gratifying results. This motion is known among them as *terrestrial gravity*, and is exhibited more forcibly by bodies falling to the earth in the direction indicated by the plumb line, which, regarding the earth a sphere, is always perpendicular to the surface of stagnant water, and would be through the centre of the earth: as it has been demonstrated that a sphere attracts substances as though all force was concentrated in the centre of the sphere.

"The philosophers, discovering that this motion is uniformly accelerated from whatever height the bodies fall, and being experimentally proven that the spaces passed through are as the squares of the times of descent, it became a question to determine the velocity communicated to a body falling freely in a given time. The philosophers not being able to do it by direct experiment, they

"By this hypothesis are explained the inequalities in the orbits of planets and their satellites; is determined the figure of the Earth; and is given the reason of the precession of the equinoxes, and the tides of the ocean.

"Owing to the force of gravity being directly to the mass, the Sun, on account of its immense size, is the centre of the planetary movements. But the universality of gravity affects the movements of every body revolving in space, and, consequently, they are made to deviate from the paths which they would take if left to the action of the Sun alone.

"To determine the amounts of these deviations, has been the question among philosophers, ever since the discovery of the law of gravitation; but the great number of these bodies thus reciprocally acting upon each other, renders the solution of this question extremely difficult, and far beyond the analytical powers of any known calculus. And to obviate these difficulties as much as possible, the problem has been reduced to the system of three bodies; and, in this way, the perturbations in parts of the planetary system have been determined; but, by reason of the deficiency of the analysis, these parts cannot be blended together so as to constitute a whole, and explain the ultimate results of the mutual attractions—the periodic and secular inequalities in their orbits. So accurate, however, are the compensations of the three elements of the planetary orbits, that one of

them is subject to the periodic fluctuations only, and the others, though affected by both the periodic and secular inequalities, still their secular changes are so limited that they ultimately adjust themselves; and these two elements of the orbits are so intimately connected, that what is gained by one orbit is eventually lost again amongst the other orbits. Thus the system contains within itself no element of destruction, and is calculated to endure forever.

"Now, is not the theory of gravitation established, by the *experimentum crucis* demonstration?"

The Man of the Sun responded—

"*Petitio principii.* I will assume the *onus probandi*, and I will exhibit, with as much brevity as possible, the absurdities of the arguments you have employed in favor of the theory of gravitation, and the incongruities of the reasoning you have displayed in endeavoring to give plausibility to the *law* of gravitation. A clear conception is necessary for just judgment and correct reasoning; and philosophers have an obstacle to contend with, of no common difficulty, when they attempt to reason about the '*attraction of matter*,' which they cannot define, which they cannot account for, and which they cannot bring within the jurisdiction of their senses.

"The phenomena which they observe, and call by that name, they acknowledge themselves wholly unable to explain; hence, any interpretation of those phenomena which they are able to give,

base their reasoning upon what they did not regard as being actually true? And what is the value of such reasoning? When experimenting with the *plumb line*, they assume that the direction of the plumb line is towards the centre of the earth, as they had adopted the 'centres' as *the basis of their reasoning;* but they also regarded the 'centres' *mathematical points*, and consequently, incapable of exerting any force; therefore, if the plumb line tends towards the *centre* of the earth, it can not be on account of any force exerted by *that* centre, but it must arise from some other circumstance. But they have not proven that the line tends to the centre of the earth; because at the base of mountains the plummet is drawn from the usual direction, which is perpendicular to the plane of the sensible horizon. And *two or more* lines at different distances from each other can be perpendicular to the *same* plane of the sensible horizon; and are, consequently, parallel to each other.

"This is the condition of a *level* surface; as the distinction made by philosophers between *true* and *apparent* levels is altogether nugatory. Because, to establish the true level, as it is called, the figure of the Earth must be known; and to satisfy *that* true level, the Earth must be a perfect sphere: the former is in doubt and the latter is not a fact. There have been three methods used by them to determine the form of the Earth; and though they apparently prove a certain figure for the Earth, yet when these methods are properly investigated

and analyzed, the *petitio principii* will be fully illustrated.

"The three methods are—first, by means of the pendulum; second, the measurement of a degree of latitude on the Earth; and third, by the inequalities in the orbit of the Moon. In their conclusion upon the oscillations of the pendulum, the philosophers had not yet discovered that all telluric substances are susceptible of *magnetism of rotation;* and the oscillations of the pendulum render the pendulum *transitorily magnetic*; hence, when the pendulum is at the Equator, being then at the greatest distance from the Magnetic Poles of the Earth, the oscillations are very slow; and when the pendulum is at the Poles of the Earth, being then nearest the Magnetic Poles of the Earth, the oscillations become very fast; hence, TERRESTRIAL MAGNETISM accounts why the number of oscillations of the pendulum increases when the pendulum is removed from the Equator to the Poles; which, like the magnetic needle, shows its proximity to the Magnetic Pole; not to the *centre* of the Earth; hence, the form of the Earth can not be discovered by the oscillations of the pendulum.

"The second method is equally at fault; because before a degree can be measured the form of the Earth must be known: and always in the measurement of a degree of latitude, the form of the Earth is *assumed;* hence, the very thing which was thought to be proven by the measurement of the degree of latitude, is the basis by which the meas-

urement is to be made, and consequently the measurement does not confirm it, and the form of the Earth is required to be otherwise established before even the measurement based on it can be accepted as correct.

"The third method employed by philosophers is the inequalities in the orbit of the Moon; that is, the perturbation in the Moon's latitude and longitude; but to account for this perturbation, a certain compression is given for the ellipticity of the Earth, by which the irregularity in the Moon's latitude and longitude is thought to be occasioned; hence, this method does not give the configuration of the Earth; because *the assumption of the compression* leaves unsubstantiated the point in dispute. And to derive any figure for the Earth from this method is plainly the *petitio principii* reasoning.

"Philosophers commonly resort to what they call *ocular demonstration*, by watching the approach of a ship at sea, they reason that, because the masts of a ship are seen before the hull, the surface of the Earth bulges up between the spectator and the ship; hence, they think *this* proves the earth to be round. Now, there is one fact which philosophers overlook, namely: the horizon is always on a level with the eye of the spectator, and this horizon is the limit, on an extended surface, of the spectator's vision; consequently, between the eye of the spectator and his horizon there is apparently a gradual ascent of surface *all around* the spectator, and to whatever height the spectator as-

cends this will always be so; and immediately beyond his horizon, the surface of the Earth is outside of the spectator's vision; hence, an object which is on *that* portion of the Earth's surface can not show to the spectator its part *nearest* the surface, and the spectator will be able to see its uppermost part only, if it be sufficiently high, and not until the object reaches the horizon of the spectator will he be able to see the *entire* object. This is a mere *optical illusion* and proves nothing, and it has the effect only of making the spectator appear in the centre of a great *concavity* of the Earth's surface, when he is at sea. Hence, the figure of the Earth not being determined, the distinction of true and apparent levels cannot be sustained: and a *level* surface is the plane of the sensible horizon; therefore, what philosophers denominate the *true* level, is not only at variance with reason and fact, but it takes for granted the thing in question—that is, the figure of the Earth.

"Now, the two or more plumb lines being parallel to each other, however far the lines be extended towards the Earth, they will never meet each other, and consequently they do not tend to the centre of the Earth. The philosophers display not only an ignorance in their investigations, but inconsistence in their reasoning and error in their judgment. The property that a sphere attracts substances as though all force is concentrated in the centre, is an assumption which was *necessary* to their argument, and is obviously contradictory.

In their calculation to find the 'force of gravity,' one element of the equation is fallacious, which renders erroneous not only the numeration for the velocity of descending bodies, but it makes nugatory the immense and elaborate computations in which this element enters the *functions* in their mechanical and astronomical analyses. This element is the *ratio of the circumference of a circle to its diameter.* It is absolutely necessary that its fundamental be well established, so that its numerical properties can be accurate and efficacious.

"But to fix this geometrical basis the ingenuity of the acutest mathematicians have been employed in vain; which arises from the circumstance of the deficiency of the mathematical knowledge possessed by the philosophers in regard to the *curve.* Having no definition for the curve which forms the circumference of the circle, as I stated before, they have based the whole of their geometrical science upon the *straight line;* and for this reason their mechanical and astronomical deductions are expressed in values derived from the *properties* of the straight line.

"Hence, whenever treating of the area and periphery of curvilinear spaces, they have been compelled to base their reasoning upon what they had previously learned concerning the straight line; and, consequently, their conclusions are impracticable, and show incongruities intolerable to the strictness of geometrical investigations. In the demonstration to find the *area* of the circle,

and from which is derived the *periphery*, they have undertaken to substantiate the proposition *That the area of the circle is equal to the rectangle of the* RADIUS *and a* STRAIGHT LINE *equal in length to the semi-circumference*, by what is called the *Reductio ad Absurdum*, a species of sophistry whose arguments are based upon suppositions known to be false, for instance, to prove equality between two magnitudes, a circle A, and a rectangle B, described on the radius of circle and a straight line equal in length to the semi-circumference. For the sake of argument, the rectangle is supposed equal to another circle C, greater than the rectangle, and because absurdity results, it is concluded that the rectangle can not be equal to any circle greater than the circle A, when, in the process of reasoning, the properties of the circle A were entirely *ignored*, and the *argument* conducted altogether upon the relations between *the rectangle and the circle C;* therefore, the rectangle is not shown equal to the circle A, because *the circle C is not proven to exceed equally circle A and the rectangle.* And in the supposition that the rectangle is equal to a circle D, less than the rectangle; because absurdity results again, it is concluded that the rectangle cannot be equal to any circle less than circle A, when, in fact no proof is given that the circle D is exceeded equally by the rectangle and circle A, which must be shown in order to prove equality between the rectangle and circle A. That is, they first reduce the *contrary*

of the proposition to the condition of the *impossible*, and then argue the truth of the *opposite;* or of the proposition itself, by the argument leading to an absurd conclusion. That this is a *sophism* is evident.

"Where the contrary of a proposition is absurd, the opposite to the contrary, or the proposition itself, should be true. But in the *Reductio ad Absurdum*, the premises are false; hence, the conclusion is absurd; whence it follows that the conclusion is absurd because the premises are false; and in this manner is shown the absurdity of reasoning from false premises, but in no way is the proposition in question established. Had the *Reductio ad Absurdum* been deduced from *correct* premises, then the proposition would have been established.

"Mathematicians, conceiving the proposition demonstrated, it became necessary to know the numerical values in order to meet all requirements; and this was attempted by a *method of exhaustions*, which, by regarding the circle the limit of inscribed and circumscribed polygons, gives the *approximate* values only; and in a science like the Mathematics, where so much exactness is required, and where so much is claimed, it is astonishing how mathematicians can be contented with *approximations*, when all their investigations depend for utility upon accuracy. The area and periphery of the circle being thus obtained, are erroneous; and the *ratio of the circumference to the diameter* being derived from the relation between this *area* and

periphery of the circle is, therefore, fallacious; whilst all calculations in which this ratio enters are thereby wrong, and all conclusions therefrom are incorrect.

"The law of gravitation is *hypothetical*, and instead of being confirmed by the measurement of a degree of latitude on the Earth, the measurement needs confirmation itself, on account of insuperable obstacles; and if a degree of latitude could be measured, its measurement would be of no use to *gravitation*, which is a NONENTITY. Hence, it does not follow that the inequalities in orbits, precession of the equinoxes, tides of the ocean, and figure of the Earth, are explained by the *theory*, or regulated by the *law* of gravitation; and, it is not the preponderance of *matter* which makes the planets revolve around the Sun, and the satellites revolve around the planets: these revolutions are due to another circumstance, which I can better explain hereafter.

"While those *compensating influences*, which have given vitality to *matter*, which direct the remote nebulæ hidden in the profundity of distance, which harmonize the separate movements of those *life-exhibiting* bodies pursuing their erratic courses so busily around you, and which preserve the grand machinery of the Universe, are the *attributes* of OMNIPOTENCE, OMNIPRESENCE, and OMNISCIENCE."

I responded to the Man of the Sun—

"The mathematicians use the quantity 3.1415926

as the *ratio of the circumference of a circle to its diameter*, in their calculations for Astronomical, Mechanical, Nautical, Surveying, and Engineering purposes. And their calculations are distinguished for their exactness and practicability. While in astronomical phenomena, the preciseness with which *eclipses* are predicted, even centuries before they occur, to the moment of time, and the correctness with which the movements and position of celestial bodies are determined, have produced in the minds of the people of the Earth a conviction of the truths of the formulæ upon which the calculations are based; as here we have deductive arguments inductively confirmed; thus bringing to the tribunal of the senses the most *recherché* of hypothetical reasoning. And the various arts and works of the people on the Earth sufficiently demonstrate the accuracy of mathematical computations, the quantity 3.1415926 is entirely used, and is relied upon, for these considerations, as expressing indisputably the relation between the circumference and diameter of a circle.

"For, according to the nature of mathematical investigations, if an error enters into any of the processes, that error becomes multiplied by every operation, and is clearly exhibited by the falsity of the results, or the absurdity of the conclusions."

The Man of the Sun answered:

"*Fallacia accidentis.* There are many persons on the Earth who think themselves mathematicians

because they know the rules, and understand the applications of the principles of Mathematics; but who are quite ignorant of the origin of its fundamentals. And you have expressed yourself fully in accordance with their convictions, and equally to the extent of their knowledge.

"That Geometry is the basis of mathematical science is well known; and how narrow this basis is, I have endeavored to show you, when I called your attention to the definitions given for the straight line and the curve, where the former is correctly defined; but the latter, on account of its many varieties, cannot admit of the general definition for the individual characteristics; and these characteristics are so distinct, that a separate definition for each is absolutely required before they can be successfully treated in the *elements* of Geometry.

"In the absence of these individual definitions for the curve, mathematicians have been forced to confine themselves to the properties of the straight line, and construct the science of Geometry upon it. The Geometer discovers the properties of the straight line, and the Trigonometer applies these properties for the solution of the *triangles*.

"The triangle being the simplest form of rectilinear figures, and all other rectilinear figures being resolvable into triangles, hence, when the problems of triangles are solved, their solutions lead to the solutions of all rectilinear figures. The *angles* and *sides* are the parts of the triangle,

and from them are derived its properties: the Geometer unfolds the proportions between them, and the Trigonometer investigates their values, determines the formulæ expressing the relations between them, and applies their geometrical properties. The Trigonometer considers principally the *angle*, and treats of the proportions existing between its sine and co-sine, its tangent and co-tangent, its secant and co-secant, its versed-sine and co-versed-sine. These are all straight lines, and they derive nothing from the *arc* which is sometimes used in connection with the angle, as the fundamentals of Trigonometry can be explained without any reference to the circle. The Trigonometer having ascertained the various connections of the angle, proceeds next to affix the signs depending on the value of the angle, which are important in some of the calculations. After which tables are computed showing the natural and logarithmic values of trigonometrical lines. In the computations of these tables various formulæ and methods are used, but the most common is the rapidly converging series discovered by Mechin.

"The circle being used on account of *perspicuity* in explaining the connections of the angle, mathematicians associated the circle with the trigonometrical lines: and regarded the value of the angle as depending on the arc subtending it; hence, they adopted the quantity 3.1415926, because they considered this the ratio between the circumference

and diameter of the circle: but they fail to perceive, that, in order to obtain their trigonometrical functions, THE VALUE OF THE ARC SUBTENDING THE ANGLE WAS NOT REQUIRED, and consequently, *the ratio of circumference to diameter of the circle was not used*, because the whole trigonometrical computations are based upon the value given to the *sine*, the *radius* of the circle being known. And when the quantity 3.1415926 is employed, the value of the *sine* is the proportional part of 3.1415926, as the angle is the proportional part of 180 degrees; hence, 3.1415926 is the sum of the *sines* contained in 180 degrees, not the sum of the *arcs* contained in 180 degrees or the *semi-circumference*. Therefore, you see, the trigonometrical calculations are not based on the ratio of circumference to diameter of the circle; although 3.1415926 is regarded by mathematicians as expressing that ratio. And because trigonometrical calculations are minutely correct, and because they are considered based on that ratio; and because 3.1415926 is regarded that ratio, these are no reasons why 3.1415926 *is* the ratio of circumference to diameter of the circle, because trigonometrical calculations are just as correct when they are derived from 2.7182818, the basis of the Napierean logarithms, which is not the ratio of the circumference to diameter of the circle.

"And other formulæ and methods give just as precise trigonometrical results as either of the foregoing, and which are not derived from the above ratio. Hence, the accuracy of trigonome-

trical calculations does not sustain the quantity 3.1415926 as the ratio in question, because their accuracy can also be maintained when that quantity is not used. The accuracy of trigonometrical calculations is on account of the discovery of the proportions between trigonometrical lines, and because these lines are so intimately connected together that their values preserve a consistence which renders practicable the various formulæ derived from them. These formulæ are the basis of astronomical calculations; and account why eclipses and other phenomena can be so correctly determined, because astronomical subjects are treated by the properties of the straight line; hence trigonometrical formulæ thoroughly express the results of astronomical observations. The correctness in the various mechanical, nautical and engineering purposes of the people of the Earth, are easily explained by the foregoing considerations.

"There is no possible process by which the ratio between the diameter and circumference of a circle can be numerically expressed except by *approximation*; hence, for mathematical uses, all results based upon this *approximation* are, consequently, erroneous; as I have before stated. But the fact of there being an invariable ratio between the diameter and circumference, which fact has been geometrically established and being well known to geometers, there is no need for its demonstration here; it follows that when one diameter is double

the length of another diameter, that the circumference of the first diameter will be double the length of the circumference of the other diameter. Hence, it is only necessary to assume any given length for a diameter, as one inch, one foot, one yard, or one mile, and the *circumference* will be a *unit of measure* to find the length of any circumference in terms of the *unit of measure:* for instance, let there be an arc of sixty degrees of the circumference whose diameter is four feet: then the arc will be *one sixth of* four times the circumference whose diameter is one foot, or *two-thirds* of the circumference whose diameter is one foot. Hence, by using the *circumference* of some given diameter as a *unit of measure*, a very simple and accurate *means of measure* for circumferences is obtained.

"Now, since the side of an inscribed rhombus in an ellipse is the mean proportional between the diameter and radius of a circle whose circumference is equal in length to the periphery of the ellipse, the same circumference used as a *unit of measure* for circumferences of circles, can be used to determine the length of peripheries of ellipses. Hence, making the circumference of a given diameter *a unit of measure*, a *means of measure* is obtained which can be usefully and extensively applied, and accuracy substituted for *approximations* in mathematical, astronomical, mechanical, and other calculations.

"The calculations based on experiments with the pendulum cannot establish a law for the falling

of bodies near the surface of the earth, nor determine the diversified movements of the sidereal bodies revolving in their orbits throughout space; because, as the pendulum becomes transitorily magnetic its oscillations are regulated by its proximity to the Magnetic Poles of the Earth, and consequently the oscillations will vary at all places upon the surface of the Earth; and no mode of procedure can be adopted to utilize so uncertain an element of calculation as the movements of a pendulum, influenced as the pendulum will be by its degree of magnetism, and also by contraction and expansion; for although the last two may be to a certain extent compensated, still in the vast scope of space and time in which Nature operates, the infinitesimal discrepancies and irregularities which escape the knowledge and senses of man, become enormous and effective; so that the limited resources and circumscribed facilities of man prevent him by his experiments from interpreting laws which regulate the phenomena of Nature and from codifying reasons, whys and wherefores, for them.

"The reasoning faculties of man, together with his natural instinct, lead him to seek pleasure and to shun pain; and all the manifold fabrications, works, manufactures, arts and pursuits with which he has exercised his ingenuity and invention for the enjoyment of pleasure and the avoidance of pain, have been permanent gains to him. Placed as he is, amidst a vast concourse of objects to stimulate

his exertions, with a body open to various sensations and a mind perceptive of the keenest susceptibilities, he is forced to gather around himself things conducive to his happiness: hence, for his body, he will construct shelter, fabricate apparels and garments and procure sustenance; and as his habits have been provident, so will he have the means and opportunities to luxuriate in refinements, embellishments and enlightenments in accord with the disposition of his mind. All these things are easy of accomplishment for his abilities: but when he strives to go beyond their limits, he will meet with checks, perplexities and disappointments; he will torture his flesh and weary his spirit. Why? Because his condition in life is a subordinate one; he exists without his own volition; he is subservient to the circumstances with which he is surrounded; he has a nature conscious of impressions only, and an individuality affected by sensibilities; consequently, he has no free will, no creative powers, and no superlative intelligence, and his efforts to divine the purposes of creation simply react upon himself and consume time and opportunities which could be more profitably employed."

BENSON'S GEOMETRY.

THIS work condenses the essential propositions of Geometry, simplifies and arranges them to avoid entirely the *Reductio ad Absurdum* method of reasoning. It contains numerous and copious corollaries and scholiums, and valuable exercises in Elementary Geometry and Trigonometry; and is adapted as a text-book for schools and colleges. Every true proposition is susceptible of *direct* demonstration, which mode of reasoning is more in accordance with the strictness of geometrical investigations, is more agreeable to the nature of geometrical truths, and approaches more to the spirit of geometrical science, than the illogical *Reductio ad Absurdum*, where the premises are fallacies, the arguments are sophistical and the conclusions are absurd; and which is not to be mistaken for the *Negative Reasoning* of Logic; because the *Negative Reasoning* has no false premises and no absurd conclusion. The *Reductio ad Absurdum* is a blot upon the science of Geometry, and its disuse is demanded by every consideration of Truth and Science. "BENSON'S GEOMETRY" is celebrated from the numerous criticisms which have been made upon it; and the indorsements it has received from prominent mathematicians everywhere entitle it to be esteemed the most correct, the most progressive and the most complete Geometry ever published.

COMMENDATORY.

ROOMS OF THE NEW YORK ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND ART,
February 28th, 1867.

Extract from the transactions of the Association for the Advancement of Science and the Arts:

"At a meeting of the New York Association, held February 25, 1867, a paper on a new method of demonstrating the propositions of Geometry, denominated the *Direct Method*, in place of the one in use, and called the *Indirect Method*, was read by Lawrence S. Benson, Esq., which method the writer proposes to introduce into schools and academies.

"After the reading of the paper, and the discussion of its merits, the subject was referred to Professor Fox, Principal of the Department of Free Schools of Cooper Union, and to Professor Cleveland Abbe, for examination and report. It was also moved and carried that the report when received be referred to the Section on Physical Science for final disposition.

"The section after reading the report of Professor Fox, the letter of Professor Abbe, and the opinion of Professor Docharty, who had been invited to examine the work, feel justified in commending this work as worthy of patronage. Professor Fox in his report says: 'The design of arranging the Definitions, Axioms and Propositions of Geometry, so as to use only the Direct Method of demonstration, is a good one, and when arranged in the form of a neat elementary text-book, will doubtless do much good, as the Direct Method is much more easily understood than the Indirect Method, by beginners.'

L. D. GALE, M. D.,
Gen. Sec. of the New York Association for the Advancement of Science and the Arts."

THE COLLEGE OF THE CITY OF NEW YORK,
COR. LEXINGTON AVENUE AND 23D STREET,
NEW YORK, *January 3d*, 1867.

"I have had several interviews with Mr. Lawrence S. Benson scientific subjects, and from his conversation, together

with the Essays which he has published, I esteem him an excellent scholar and fine mathematician. He has a desire to establish the Elements of Euclid *in all cases*, independently of the demonstration known as the *Reductio ad Absurdum*, 'a consummation devoutly to be wished.'

"Whatever aid or advice you can render him in the furtherance of this object, will tend to the advancement of true science. Yours truly,

G. B. DOCHARTY."

DEPARTMENT OF PUBLIC INSTRUCTION,
SUPERINTENDENT'S OFFICE, 146 GRAND STREET,
NEW YORK, *Oct. 13th*, 1868.

"On the recommendation of Prof. Docharty, of the College of the City of New York, and upon a careful examination of the work, I recommended Mr. Lawrence Benson's Geometry as in my judgment worthy of a place in the list of text-books on that science, for the use of the schools in the City of New York, and it was accordingly placed on the list by the committee on the Course of Studies and School Books, and adopted by the Board of Education.

S. S. RANDALL,
City Superintendent."

Prof. James H. Carlisle, Wofford College, Spartanburg, S. C., writes:

"Some of your definitions strike me as improvements on those which have been copied from one work into another, for many years. Your judicious selections from English works not in common use in our country, and your own contributions to this old, but still fruitful science, will give a peculiar value to your work."

Prof. Harris, Lexington, Georgia, writes:

"I have carefully examined your 'ELEMENTS OF EUCLID AND LEGENDRE,' and pronounce it the best work of the kind I have seen. I am pleased with your direct course of reason-

ing, and the general classification of the work. You have succeeded admirably in combining the essential propositions of geometrical science in so small a compass, that in my opinion, a pupil may learn, yes, master the whole science, in the same time that he, in former text-books, would have completed five books of it. Your exclusion of the *Reductio ad Absurdum* is a decided improvement in geometrical science."

Prof. J. D. Stewart, Classical High School, Memphis, Tenn., writes:

"I have just read your circular addressed to teachers in the United States. I am at once convinced of the justness of the points you make against the 'Legendre of Davies.' I hail with delight the abandonment of the *Reductio ad Absurdum* method of reasoning. Allow me to congratulate you on this advance in the science of Geometry—a science which is the foundation of the mathematics."

The President of Carolina Female College, Ansonville, N. C., writes:

"I have examined the 'ELEMENTS OF EUCLID AND LEGENDRE' critically, and indorse it as an evident advance of the science, in that it simplifies and meets the capacity of learners, retains all the essentials of the science, and is equally as competent for mental discipline as the old *Reductio ad Absurdum.*"

From the Scientific American:

The Elements of Euclid and Legendre, with Elements of Plane and Spherical Trigonometry. By Lawrence S. Benson.

"The author of this treatise has prepared and published a text-book, adapted for the use of schools and colleges, the plan of which being the reducing of geometrical science to the smallest compass, such propositions are only introduced in it as are required to substantiate the principal theorems, by which the principles of Geometry have practical applications in Trigonometry, Surveying, Mechanics, Engineering, Navi-

gation, and Astronomy. A new and important feature of this work is the establishment of all geometrical propositions by the direct method of reasoning, dispensing entirely with the *Reductio ad Absurdum*, or indirect demonstration, the author's argument being that every true proposition must be susceptible of proof without any circuitous process as that heretofore employed for demonstrating certain propositions. The work before us bears the commendation of President Webster and Professor Docharty, of the College of the City of New York, Professor J. G. Fox, Principal of the Cooper Union Free Schools, also the Superintendent of the Board of Education of this city, and has been entered on the list of text-books for the ward schools of this city."

From the New York Tribune:

"The method adopted by the author will command the approval of intelligent instructors from its compactness and lucidity, and cannot fail to facilitate the progress of the pupil in a practical mastery of a fundamental branch of mathematics."

From the American Publisher and Bookseller:

"Mr. Lawrence S. Benson is the author of 'BENSON'S GEOMETRY,' containing the Elements of Euclid and Legendre, simplified and arranged to exclude from geometrical reasoning the *Reductio ad Absurdum*. Whilst we have ever regarded the *Reductio ad Absurdum* as one of the most convincing methods of geometrical reasoning, it would be presumptuous on our part to set our judgment against that of the many able Geometricians who have objected to its use. Mr. Benson claims that all propositions can be demonstrated by what is called the direct method, and in the cursory review of the work that we have been able to make, we are inclined, at least, to admit there is something more than an air of plausibility in his exposition of the new system. Without attempting an analytical review of the work, we venture to commend it as being at least worthy the attention of mathematicians."

And it may be well to state here, that Professor Charles Davies, LL. D., formerly of West Point Military Academy and Columbia College, New York, recently published a little book in which he repudiated the *Reductio ad Absurdum* method of reasoning, which is significant from the fact that he had for nearly forty years previously defended it in his "Legendre."